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HANDBOOK

OF THE

Practice and Art

OF

PHOTOGRAPHY.

BY

DR. HERMANN VOGEL,

TEACHER OF PHOTOGRAPHY AT THE ROYAL TECHNICAL ACADEMY AT BERLIN; PRESIDENT OF THE SOCIETY FOR THE PROMOTION OF PHOTOGRAPHY AT BERLIN; EDITOR OF THE "PHOTOGRAPHISCHEN MITTHEILUNGEN;" MEMBER OF THE INTERNATIONAL JURY OF THE PARIS EXHIBITION OF 1867, AND THE VIENNA EXPOSITION OF 1873; HONORARY MEMBER OF THE NATIONAL PHOTOGRAPHIC ASSOCIATION OF THE UNITED STATES.

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PREFACE

TO THE SECOND GERMAN EDITION.

THE first edition of this work met with a more rapid sale than I dared to hope, and the leniency of the public gives me the conviction that in spite of the shortcomings in the arrangement and the contents, which are well known to me, I have come up to the requirements of the times; at the same time I feel it obligatory to change the second edition in such a manner as to do full justice to the wants of the public.

Considering the ceaseless progress of photography this task was not an easy one. Whole chapters had to be rewritten and rearranged, and everywhere the abundance of new material had to be put in its proper place. In some parts of the book not a vestige of the old work has been left, as those will readily observe who closely scrutinize the chapters on Photography with Chromic Salts, the Changes of the Silver Picture, the Alkaline Development, the Collodion, the Arrangement of the Gallery, the Chemical Action of Color, Dry Plates, Enlargements, Carbon Process, the Reproduction of Negatives, the Transfer Process, Perspective, Pose, and Standpoint, etc., etc.

The size of the work has been much increased. I should have much liked to introduce the new chemical symbols in place of the old ones, but experience has taught me that the practical workers, and these are the majority of our readers, are scarcely familiar with the new symbols, and therefore the old symbols are retained in this edition.

The retouch has only been treated superficially, as this subject has been fully treated by Mr. Hartman in the third edition of Grasshoff's Retouch.

May the book in its new dress meet with the same favorable reception which was awarded to the first edition.

PROFESSOR DR. H. VOGEL.

PREFACE

TO THE SECOND AMERICAN EDITION.

THE second American edition of my book has been entirely remodelled so as to meet the requirements of the age. The material has been increased and carefully revised. Of new chapters I mention only the Negative Retouch, which was left out in the first German and American editions; also numerous hints on Paper, Collodion, Landscape Photography, etc.

May the book meet with the same favorable reception as the first edition and the Reference-book.

PROFESSOR DR. H. VOGEL.

INTRODUCTION.

A CAREFUL study of the history of invention will show but few periods as rich in new ideas and facts as the past hundred years.

With the rise of the explaining natural sciences—chemistry and natural philosophy—commenced a new era by applying the discoveries to actual life and industrial pursuits. Thus originated the *steam engine*, *gas*, *sulphuric acid*, the manufacture of *soda*, *beet-root sugar*, the manufacture of *ultramarine*, not to mention numerous other things in which the physical or chemical action of heat was used in a new form.

In an analogous manner we see another of the natural forces, formerly unused, enter as an active agent into our industry,—*electricity*. Weber created the *electro-magnetic telegraph;* Jacoby the *galvanoplastic* process.

Finally, the present age brought forth an art in which the *chemical action of light* is the principal agent. *This art is Photography.* It has existed only twenty-five years, and still we may say that no invention of this century has since its first appearance experienced such a gigantic development and exercised so powerful an influence on our social, artistic, and scientific relations as this one. At first a mere method of taking portraits, its application has now extended to almost all the branches of human knowledge and science. It supplies a natural self-print in the widest sense of the word,—it furnishes the naturalist with faithful representations of animals, plants, and minerals; the geographer obtains from it the basis from which to develop his maps; it makes for the engineer in a few moments faithful copies of the most complicated machinery, and reproductions of his drawings and plans, which would occupy the time of the most skilful draughtsman for weeks; it supplies him with an authentic foundation for the construction of plans and maps; it is employed successfully in lithography and porcelain painting; it serves the artist for multiplying his productions, and places copies of inimitable truthfulness at a moderate price within the reach of all; it is as important an auxiliary for developing a taste for art in the people as the invention of printing is for the dissemination of knowledge.

Let us briefly consider how this art developed itself. There are many inventions which originated by accident, by the favor of the moment; as instances, we may mention gunpowder, the deflection of the magnetic needle by the galvanic current, and the telescope; but others required years of thoughtful study and experiment before they could take their place amongst the inventions. Photography belongs to the latter class.

It was long known that chloride of silver would turn dark on being exposed to light. It was also known that paper, the skin, etc., when wetted with a solution of silver, would be discolored by the light of the sun. But only in the beginning of this century the idea was conceived to use these facts for the production of pictures by the agency of light.

Two Englishmen, Davy and Wedgwood, made the first experiments

of the kind in the year 1802. They placed a piece of paper in a solution of silver, brought it into contact with an opaque object—for instance, a silhouette—and exposed it to sunlight. All that part of the paper not covered by the silhouette turned brown by the action of light; the balance of the paper remained white; thus a white picture on a brown ground was produced. *This was the first light picture.*

Unfortunately these pictures were not permanent. The part which remained white soon darkened by the action of diffused light, and finally the picture disappeared by the influence of the same agency to which it owed its origin.

Davy photographed in this manner the image of the solar microscope.

Almost simultaneously with Davy and Wedgwood, a Frenchman, by the name of Niepce, entertained the idea of making pictures by the agency of light.

From the year 1814 he worked incessantly; he experimented for years, but approached only step by step to the desired end,—the production of *permanent* pictures by the agency of light.

While by the method of Wedgwood and Davy only flat objects, which could be placed in close contact with the sensitive paper, such as leaves, drawings, etc., permitted of being copied by the process, M. Niepce aimed to obtain representations of all kinds of objects in nature,—portraits, landscapes, etc. By the aid of the camera obscura, which the physicist Porta invented in the sixteenth century, he succeeded in this.

Wedgwood had already the idea to fix the charming pictures of this instrument on his paper, but it was not sensitive enough. Niepce resorted to another preparation sensitive to light,—namely, a solution of *asphaltum in oil of lavender.* With such a solution he coated a metal plate and exposed it for hours in the camera. The places which had been exposed to light became insoluble, and in the after-treatment with ethereal oils remained on the plate and formed a picture.

By this process Niepce produced imperfect light pictures as far back as 1826—the so-called heliographs—but the production was too difficult and complicated to give it great practical value.

In the year 1829 Niepce joined Daguerre, who was working in the same direction. The two labored together until the year 1833, when Niepce, full of grief over his twenty years of unsuccessful toil, died. Daguerre became the sole heir of his ideas, and a few years after Niepce's death the great problem, *to produce by the agency of light a permanent picture in an easy and practical manner,* was solved. In the year 1838 he placed the first proofs of his process before three members of the French Academy,—Humboldt, Biot, and Arago.

The excitement was immense; everybody was anxious to learn how these pictures were made. Arago induced Daguerre to publish his invention, and the Government granted him a pension of six thousand francs. At the same time a pension of four thousand francs was granted to the son of M. Niepce. On the 19th of August, 1839, the secret of the production of these pictures was given to the world in the public session of the Academy. The concourse was enormous. All the votaries of

science and art of Paris were assembled in the Palais Mazarin. Thousands, who could not gain admission, besieged the doors. The busy newspapers soon spread the news of this discovery throughout the world, and in a few years disciples of the new art could be found in all the principal cities of Europe and America. Morse, the celebrated inventor of the well-known telegraphic apparatus, was the first who introduced the new art on the American continent.

Daguerre accomplished his purpose in a way very different from Niepce and Wedgwood.

He employed as the sensitive substance the iodide of silver, which he produced by exposing a plate of silver to the vapors of iodine. The light impression which such a plate receives in the camera is at first invisible, but as soon as the plate is exposed to the vapors of mercury the picture appears with all its details.

This is a cardinal point in Daguerre's invention. While all the preceding experimenters tried to obtain a visible picture through the action of light only, he impressed the plate with a latent image, which only became visible by a secondary operation,—the development. In this manner light was only required for a short time to obtain a picture, and now it became possible to apply photography to living or moving objects.

While the new art—called Daguerreotypy, in honor of its inventor—held its triumphal march through the civilized world, there lived in England a rich private gentleman, by the name of Fox Talbot, who pursued the same object as Daguerre, but in a totally different manner. About the time when Daguerre presented his first picture to the members of the Academy, Talbot made a communication to the London Royal Society about a method to reproduce pictures by the aid of light. Following the experiments of Wedgwood, he took paper impregnated with common salt, and allowed it to float on a solution of silver. This paper, containing chloride of silver and the nitrate of the oxide of silver, was placed in contact with a copper-plate engraving and exposed to sunlight; it proved much more sensitive than that employed by Wedgwood. The light penetrated the white places of the engraving and darkened the corresponding parts of the underlying sheet. A white picture on a dark ground was the result,—a negative.

The operation was then repeated; the negative took the place of the engraving, a piece of prepared paper was placed under it, and by exposing them to the sunlight a fac simile of the original print was produced. This operation can be repeated at pleasure, and thus a number of positive copies can be obtained from a single negative.

By this invention of Talbot photography entered the ranks of the reproducing arts.

After the discovery of Daguerre had become known, Talbot also tried to take pictures on paper by means of the camera. He floated the paper on a solution of iodide of potassa, and again on one of nitrate of silver; when it had become impregnated with iodide and nitrate of silver, it was exposed in the camera. In this manner a latent picture was obtained in a short time, which could be made visible by employing a develop-

ment; for this purpose Talbot took a mixture of gallic acid and a salt of silver. The gallic acid reduces the salt of silver, and metallic silver finely divided forms a black precipitate, covering all the parts which have been exposed to light. A negative was thus obtained from which positives could be made in the manner described above. This process was published in 1841.

Talbot's pictures, however, compared with those of Daguerre, were so primitive and imperfect, that his process was merely considered as a curiosity, and attracted little attention. The rough texture of the paper was fatal to the delicacy which could be produced on the polished and mirror-like plates of Daguerre.

Soon, however, this was changed.

Niepce de St. Victor, a nephew of Nicephore Niepce, the friend of Daguerre, following the example of Herschel, substituted for the paper, glass plates, and made them the bearers of the sensitive film of iodide of silver. He coated these with albumen containing iodide of potassium, immersed them in a silver bath, and thus obtained a very sensitive and homogeneous film on which he could take pictures much more delicate than those on paper; but still this process offered great difficulties.

In the meantime gun-cotton was discovered by Schoenbein and Boettcher. It not only proved itself a substitute for gunpowder, but was also employed in the healing art. It was found that this substance was soluble in a mixture of alcohol and ether, and that the solution, called collodion, left a transparent film after evaporation, which rendered important services as a sticking-plaster.

Legray, in 1850, was the first who tried to use this solution of gun-cotton as a bearer of the sensitive salts of silver, in place of albumen, after the manner of Niepce, but did not succeed. Archer and Fry, in England, were more fortunate. Their experiments were rewarded with complete success, and in 1851 Archer published a complete description of his new *collodion process*, which as to the beauty of its results was in no way inferior to the albumen process of Niepce, but far surpassed it in simplicity and certainty. Archer covered plane glasses with collodion containing salts of iodine in solution, immersed them in a silver bath, and thus obtained on the glass a delicate film saturated with sensitive iodide of silver. This plate, when used in the same manner as Talbot's paper, gave a negative of extreme sharpness and delicacy, and excellent positive pictures on paper could be produced in any quantity desired by the method described above. The discovery of Daguerre was now completely superseded. The collodion process spread rapidly, and in course of time was more and more improved, and is at present the one exclusively used.

Its rapid introduction is due partly to its delicacy, its easy execution, and partly to the advantage that the collodion pictures can be multiplied in a much simpler manner than the plates of Daguerre.

These circumstances alone, however, would not have been sufficient to give it the precedence over the process of Daguerre, as the collodion plates produce at first only a negative picture. It became necessary,

therefore, to find a simple and easy way of printing positives with all the details contained in the negative, and this was finally reached through a special preparation of the Talbot paper. The latter was covered with albumen, which Niepce had already successfully employed in the preparation of negative plates, and thus the albumen paper was made a medium for the production of excellent positives. Collodion for the negative and albumen paper for the positive process form now the most important bases of our photographic pictures.

Besides these successive improvements other circumstances contributed materially to the rising importance of photography.

The optical apparatus which served to produce the pictures in the camera were improved. Petzval invented the double objective in 1841, which combines extreme intensity of light with correct drawing.

It permitted the taking of objects with very short exposure, and now portraiture was brought to its high state of perfection.

Simultaneously with this, photographic chemicals were produced of great purity and cheapness. The qualities of those already in use became better known, and the imperfect ones were replaced by more efficient ones.

Fizeau, Claudet, and Gaudin discovered the greater sensitiveness of the mixtures of iodide and bromide of silver. Goddard also introduced mixtures of iodide and bromide of silver into the collodion process.

Herschel suggested the use of hyposulphite of soda, which removes the sensitive salts of silver from the photographs, and thus fixes the picture in a permanent manner.

Fizeau introduced the gold toning bath, which removes the unpleasant color and makes them more permanent.

It is owing to these and other numerous discoveries that photographic operations have become so easy and practical, that any moderately skilful person can become an expert in a short time. The consequence has been that an immense number of people devoted themselves to the new art in the expectation of making money rapidly and without trouble.

The introduction of the carte de visite style made photography popular, and the public rushed to the galleries, which sprang up everywhere like mushrooms. In the same manner did the manufacture of photographic apparatus and chemicals gain in importance.

Optical establishments were started for the exclusive production of photographic lenses. Cabinetmakers devoted their whole attention to the making of photographic cameras, picture frames, and presses; and other accessories required special factories to supply the growing want. At present millions enjoy directly and indirectly the fruits of the beneficial invention of Daguerre and Talbot.

Many of their followers are now simultaneously investigating the hitherto unexplained physical and chemical processes of this art, to find new branches for its use, and to do away with the imperfections which still exist. Every day new suggestions are made, and a large number of photographic journals are published to register the new discoveries and to announce them to the world. It is not at all impossible

that a new and more perfect process may supersede that of Talbot in the same manner as he supplanted Daguerre. Quite a number of interesting experiments have already been made by Niepce de St. Victor, Becquerel, and Poitevin, to produce photographs in their natural colors, the fixing of which, however, has not yet been accomplished. More important and successful are the experiments to replace the expensive salts of silver required by the present process by cheaper materials.

Herschel employed first the salts of iron, Niepce de St. Victor and Burnett the salts of uran, and Mungo Ponton the chromates, as sensitive substances. The trials hitherto made have already produced remarkable results.

Poitevin's Carbon Printing Process particularly deserves in our opinion the greatest consideration of all the recent methods of printing. It is based on the sensitiveness of chromate of potash.

The aim is now to increase the productiveness of photography to an unlimited extent by combining it with lithography and metal plate printing. Fizeau was the first who tried to prepare a daguerreotype plate with acid, and thus make it suitable for copper-plate printing. As early as 1844 he furnished such heliographs. Fox Talbot succeeded in transferring the photographic picture on steel, and made a photographic steel-plate engraving. Poitevin tried to produce photolithographs, a process which has recently been highly improved by Osborne, Toovey, James, Asser, Lemercier, Burchardt, and others. The problem to reproduce line drawings has been solved and is already generally employed. The rendering of the half tones, however, still offers difficulties. These were overcome by Albert's new discovery of a process similar to photolithography. Tessie du Mothay tried to print from a gelatin film in the manner indicated by Poitevin. Albert, in Munich, improved this method to such a degree, that at present, under the name of the Albert or "Lichtdruck" process, it is practiced in numerous establishments of Europe and America. In a still more perfect manner has Woodbury solved the problem to make photographs in the printing press. He furnishes by his relief-print process, not only the most excellent pictures on paper, but also lantern slides, and stereos on glass, of a perfection equal to those made by the silver process.

Meanwhile the opticians are not idle. New instruments by Steinheil, Busch, Ross, Zentmayer, and Dallmeyer increase the capabilities of photography to an astonishing degree. In like manner has the desire to elevate artistically the mechanical productions of photography given an impetus to portrait and landscape photography. Legions in America, Adam-Salomon in Paris, Robinson in London, Loescher & Petsch in Berlin, have set a noble example, and artistic elevation of photography, be it by pose and lighting, or be it by retouching, has become the watchword of all photographers.

In this Handbook I will accordingly devote especial attention to artistic photography.

DR. H. VOGEL.

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THE

PRACTICE OF PHOTOGRAPHY.

CHAPTER I.

THE ARRANGEMENT OF THE GALLERY.

The photographer, like every other artist or mechanic, requires for his labors a place where he is protected against the influences of the weather.

These labors are of various kinds,—partly mechanical, as the cutting and cleaning of plates; partly chemical, as the preparation of collodion, silvering of paper, developing, intensifying, fixing, and washing; partly physical and optical, as the focussing and exposing; and, finally, partly artistic, as the posing of the sitter, the arrangement of the drapery, the illumination, and the negative and positive retouching. It is evident that these operations cannot all be carried on in the same room, particularly as some of them demand diametrically opposite conditions for their success. The taking of the model requires much light, while the preparation of the plates must be carried on in almost total darkness.

Every photographer needs, therefore, a suite of rooms, which, however, frequently appear reduced to two,—the studio and the dark-room.

In assigning proper localities to the different work to be performed, particular attention should be paid to separating those branches which are in their nature antagonistic.

The silver bath should not be evaporated in a room where prints are being mounted. The plate while being fixed must not be exposed to the danger of being sprinkled with the developer, not to mention a hundred other precautions.

The necessity for a division of labor and space increases with the magnitude of the establishment, in order that each particular kind of work may be carried on independently.

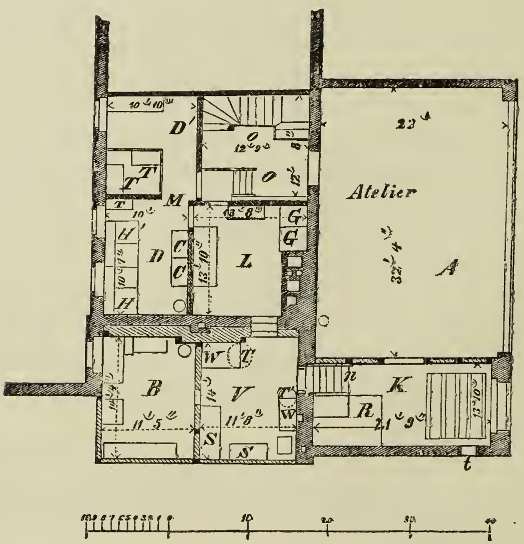
A drawback to the proper arrangement of photographic ateliers is generally met with in the fact that they are located in the upper stories of houses which were originally designed for other purposes. The consequence is that they must accommodate themselves to the already existing proportions, and this can only be done by sacrificing many advantages.

We find, therefore, the greatest diversity in the arrangement of photographic galleries. Only one principle in the above-stated necessity of a division of labor seems to be persistently carried out, namely, the separation of the negative and positive processes.

As examples of the arrangement of a gallery, we will give two practical illustrations. The one is the photographic atelier of the Royal Academy of Technology, the other the atelier of Loescher & Petsch, at Berlin. Any one who desires to arrange an establishment will find in these descriptions a guide, although local conditions will often compel a modification of these plans.

The atelier of Loescher & Petsch has this great advantage, that it has been erected exclusively for photographic purposes, which have, however, had portrait photography solely in view, while the atelier of

Fig. 1.



the Royal Academy of Technology is devoted more to technical purposes, such as the copying of drawings, machinery, etc.

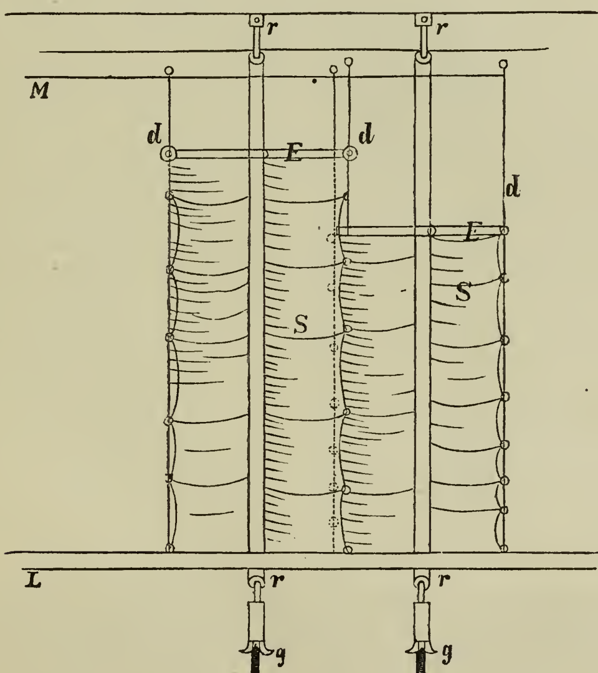
The photographic atelier at the Academy (Fig. 1) consists of a glass-

house, *A*, 32 feet long by 22 feet in width. The height of the front glass wall or sash is 10 feet 6 inches; the rear wall is 16 feet high.

The roof is only glazed for a distance of 16 feet. The atelier itself does not face exactly north, but north-northwest, conforming to the building on which it is erected. In the summer-time the afternoon sun shines on the glass-house, an evil which can only be partially remedied by awnings and curtains.

The curtains are arranged according to the old system of Loescher & Petsch, which appears the most rational, and has already been adopted by several Berlin photographers. It consists of side curtains which can be moved in a vertical direction, and top-light curtains which move parallel to the inclination of the roof. A section of the side curtain is represented in Fig. 2, and Fig. 3 represents one of the top-light curtains with the cords for moving it.

Fig. 2.

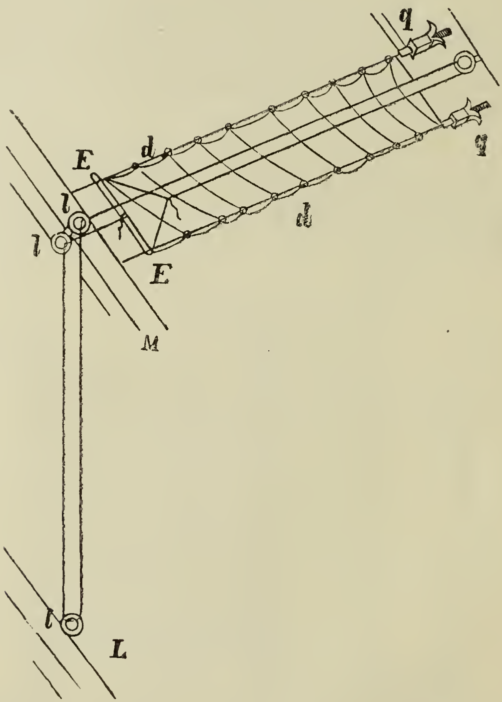


The curtains are 2 feet wide and overlap each other like the shingles of a roof, in order to exclude the light completely (see Fig. 2). The guides are thin wires, *d*, on which the iron rods, *E*, which carry the curtains, slide.

It is easy to darken the whole atelier, to make openings of 2, 4, or 6 feet in width, and of any suitable length, and to modify the direction of the entering rays in various ways.

The cords for the side curtains pass over the rollers *r*, *r*, *r*, *r*, which are fastened near the roof to the board *M*, and at the floor to *L*; the cords can be tightened by the screws, *g*, *g*. The wires *d*, *d*, of the side curtains, hang down loosely, while those of the roof admit of tightening by the screws *q*, *q* (see Fig. 3). The cords of the top curtains pass through porcelain rings, *l*, *l*, which are fastened to *M* and *L*.

Fig. 3.



The curtains are made of very opaque double blue material.

The above system was especially designed for portraiture, which, however, is not the class of work done at the Academy; still it does excellent service in the taking of plastic objects.

Immediately adjoining the glass-house, and on the same floor with it, is the printing-room, *K* (see Fig. 1), with a window facing north-northwest, and a top-light one-half the size of that which covers the atelier. A sliding door leads to the latter, which is opened when it

becomes necessary to remove the camera to a great distance from the object to be taken; by this arrangement the apparatus can be removed 45 feet from the opposite wall of the glass-house.

The width of the printing-room is only 14 feet; the length and height are those of the atelier. The top-light is, for printing purposes, a little too high. In order to bring the frames nearer to the light a movable platform of wood has been constructed, which by mechanical means can be elevated to a height of 8 feet, or lowered at pleasure.

The printing-room is divided in two parts. The back part, *R*, serves as a dark-room, where the papers are placed in the frames, and where the progress of printing is examined. The fresh copies are also kept in this room. The front part serves for exposure. A side door, *t*, leads to the roof, where, when necessary, the work can be carried on in the open air.

Immediately adjoining the printing-room, but a little higher situated than the latter, and connected with it by a staircase, are the rooms for the further manipulation of the paper prints. 1st. The wash-room, *V*. 2d. The finishing-room, *B*. The former contains two troughs lined with asphaltum. They are 5 feet long by $2\frac{1}{2}$ feet wide. They rest on the tubs, *T*. One of these troughs is for washing the fresh copies; the other for washing the fixed prints. An opening carries the wash-water with the silver contained in solution into the tub, *T*. Another opening, which can be closed, leads the waste water into the street.

The tub *T* receives the water containing soda, and *T′* the solutions which are free from this substance.

The tables, *S*, *S*, are for silvering paper; the toning is done in the light part of the printing-room.

The adjoining space, *B*, is used for mounting, retouching, and rolling the pictures, and also serves as a store-room for paper, chemicals, etc.

We now proceed to describe the apartments devoted to the negative processes. Here we have, first, a small laboratory with top-light, *L*, in which the chemicals are mixed, the baths and other substances tested. Evaporations, and all other chemical processes, are also carried on here.

In the room next to the furnace are two places for evaporation, *G*, *G*; the one for liquids containing silver in solution, the other for the solutions containing chlorine (gold solutions, etc.).

The reduction of the silver residues of the different melting processes is finally done in the large laboratory of the Institution.

D, *D*, is the dark-room for the preparation of the plates. By a

curtain, *M*, it is divided in two parts, and a space, *T*, *T*, is partitioned off in the centre for the preparation of dry plates.

In *D'* the plates are cleaned, and all the work connected with cleaning is done here.

C, *C*, is the table with the silver bath; *H* the developing, and *H'* the fixing trough. They are separated by a partition, and each trough consists of two parts. From the left part the rinsing waters, which are rich in silver, are carried in a tub underneath the table; the right-hand part serves for the final washing, and the waste water is carried off into the gutter. The width of each of the four troughs, which are lined with asphaltum, is 2¼ feet. Gas and water-pipes run of course through the whole establishment.

At *P* are shelves for plates.

The dark-room communicates with the atelier by the entry, *O*, *O*.

Perhaps it would have been better if the laboratory, *L*, had been taken for the dark-room, but the arrangement of the building would not permit it, and the peculiar construction of the basis on which the atelier was constructed caused unusual difficulties in the proper distribution of the different localities.*

The knowledge of several deficiencies in the construction of the studio of Messrs. Loescher & Petsch, which, in the course of time, became more and more annoying, and gave rise to an unpleasant feeling of being dependent on the peculiarities of the atelier, induced these gentlemen to embody their experience in a new building, which should be, as near as possible, perfection.

The principal ideas which guided them in the execution of this work were, that the photographer, by the nature of his art, is compelled to make the most of the few moments of exposure, to take into account every, even the smallest advantage in regard to illumination, the management of the decorative or technical accessories and utensils, and, finally, to avoid everything which can give trouble or become a hindrance. This is the only way to enable him to devote his whole and undivided attention to the person whose picture he is to take, and to the arrangement and the harmonizing of the principal effects. Another important point is the location of the studio. It should be located on the ground-floor; for, besides this being the most convenient for the public, such a location admits also the total exclusion of direct sunlight, by placing it to the north of a tall building. Attention should also be paid to a proper arrangement of the different

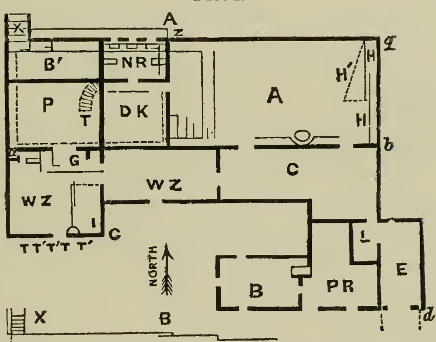
* It will be noticed in Fig. 1 that the various rooms are not on the same level, and communicate by steps with one another.

work-rooms, partly to save time, partly to enable the head of the establishment to have every department constantly under his eye. These were the general principles which Messrs. Loescher & Petsch tried to embody in their new establishment. How difficult it is to find a locality where all these advantages are combined, anybody who is acquainted with Berlin will know.

The building is located in a garden. No trees or shrubbery can have an injurious effect on the light, as for a distance of one hundred and fifty feet the space is perfectly clear.

The annexed ground-plan will explain how the different rooms are connected together. The advantages of this arrangement are, principally, that the photographer is enabled, at any leisure moment, to communicate with the counting-room, the mounting-room, the retouching-room, or the printing establishment. He can constantly overlook and superintend the working of all the different departments.

FIG. 4.



GROUND-PLAN OF THE BUILDING.

A, studio; C, counting-house; WZ, waiting-room; B, mounting-room; PR, artist's studio for coloring; P, vestibule; B, balcony; DK, dark-room; NR, room for negative retouching, underneath which are the wash-room and copying-room; T, staircase leading to the printing-room.

The main glass-room faces nearly due north, and is protected by the two-story house from the direct rays of the sun. The printing-room, the main side of which also points north, is likewise protected against direct sunlight.

The studio proper is of the following dimensions: 35 by 17 feet floor, and height from 10 to 14 feet. The inclination of the roof is 4 feet in 17, and is sufficient to remove the accumulated dirt whenever a rainfall occurs. The moisture on the inside, caused by condensed vapor, runs off through a small slit between the roof and the sides. In this way the gutters, which are generally placed below the supports, could be dispensed with. At the junction of the two glass

surfaces is a slight iron rod to carry the rollers for the illuminating apparatus, which absorb very little light. The northern side and about three-fourths of the roof are glazed. The plates of glass are 24 inches square, and only 16 bars were necessary as supports. The central ones are $\frac{3}{8}$th in. by 3 inches; the side ones are an inch thinner. In this way a broad mass of light from the north became available, which, in some particular instances only, had to be modified. It became necessary to invent an arrangement which would exclude every particle of side-light, and reduce the source of light to one opening only. Ease in the management and certainty in the effect were necessary, durability and a pleasing appearance desirable. These considerations induced Mr. Petsch to substitute for the old-fashioned curtains of doubled muslin, frames covered with some opaque material, which were easily movable and avoided all the shortcomings of the former arrangement. The old arrangement with curtains never excluded the light absolutely, while, at the same time, they would, in course of time, hang down loosely, leaving openings between the different strips, the light from which would be annoying to the sitter and interfere with a proper illumination, not to speak of the dust and unsightly appearance.

With the frame arrangement the supports for the glass became available as carriers for the frames, doing away with all the rods, wires, rings, and cords of the old establishment. The frames are made of light iron bands, covered with linen which is made water- and light-tight by a coating of glue, chalk, and oil paint.

To the supports of the roof, corner-irons *e* (Fig. 5) $\frac{3}{4}$ in. by $\frac{3}{8}$ in. are riveted, and these carry the frames. The irons have three grooves, in each of which a frame can be moved without touching the other one. Placed side by side, they cover the glazed three-quarters of the roof completely; placed one above the other, and pushed under the covered quarter of the roof, the glazed part is unobstructed. See the two cuts below:

Fig. 5.

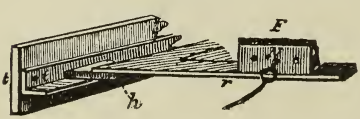


Fig. 6.

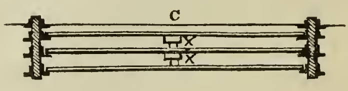


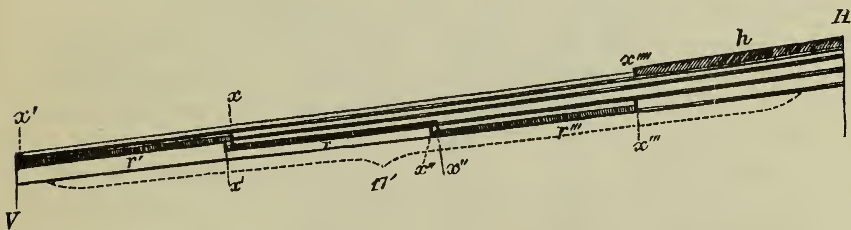
Fig. 7 will show this arrangement—cross section.

H is the rear wall; *h* a wooden covering for the roof; *r*, *r'*, *r'''*, are the frames which move in the guides as shown in the figures above. Each frame has two small hooks, *x'*, *x''*, *x'''*, etc. The frames are

moved by cords, which at H and V pass over rollers, and which at V are fastened to the first frame. In admitting light, r' will move backwards, first the hook x' will catch the corresponding hook x'' of frame r', and take the second frame along, and so all the frames will be caught in succession. Friction is partially overcome by strips of wood, h, Fig. 5, which are covered with plumbago, and placed under the frames; so also are the hooks F, Fig. 5, covered with felt to avoid jarring.

The movement of the frames is easy and certain, and the exclusion of the light complete.

Fig. 7.



The side-light is regulated in a similar manner. Instead of three frames, two only are needed. They run in a wide groove, and can be pushed partially below the floor of the studio.

The distribution and character of the backgrounds and furniture were made with due regard to the tendencies of the times, which, in costume and everything else, incline to the Rococo and Renaissance styles. With this end in view, one side of the studio is provided with furniture and drapery of the former style, and the other side with accessories corresponding with the latter taste.

The old and practical way of moving the backgrounds on rollers and horizontal rails has not been changed, excepting an arrangement by which the background can be placed obliquely to the light. The light and shade effects are partially regulated by screens and reflectors. The color of the furniture is a mixture of burnt umber and chalk, not so dark that black cloth will not show upon it.

The size of the background is 7 feet wide and 8 feet high, and as the studio is 17 feet wide, two backgrounds can be placed side by side.

In the room for negative retouching, which adjoins the studio, there are three desks side by side. Each desk has a ground-glass window $1\frac{1}{4}$ feet square; the front part of the desk can be raised or lowered so as to admit of moving the easel nearer to or further from the window. At night a lamp is used. The lamps are provided with Argand burners, and parabolic reflectors of polished metal. The

back part of the reflector being cut away, the direct light passes through, while, at the same time, the side rays also are thrown on the negative.

The other localities are not much different from those of similar establishments. A room facing south, underneath the studio, is used for printing, toning, and washing the prints. In this room the paper is also sensitized.

In the reception-rooms, the aim has been rather to please by a tasty simplicity than to dazzle the eye with gaudy splendor.

The dark-room, as well as several other localities, are heated with hot air. Above the flue in the dark-room, is a wire arrangement, on which the negatives are placed to facilitate their drying.

The arrangement for washing the pictures consists of two large tin boxes. The water is introduced through many small holes, and when it has reached a certain height, two siphons empty the boxes, and the process begins anew.

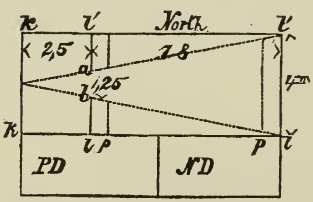
Finally, it may not be amiss to say that it is not claimed that the above arrangements are perfect, but the aim has been to go a step forward in the construction of a first-class studio.

Large Berlin galleries have frequently the printing-room over the gallery. (See the exterior of Milster's atelier, Fig. 10.)

For smaller establishments, suitable for provincial towns, we recommend the following:

The glass-house *l*, *l*, *l'*, *l'*, and the printing-house *k*, *l'*, *l*, are placed on the same floor; next comes the negative dark-room *ND*, $3\frac{3}{4}$ metres long, 2.5–3.5 metres wide, and the positive dark-room *PD*. The glass-house should be 7.84 metres (25 feet) long, and 4 metres ($12\frac{1}{2}$ feet) wide; the depth of the glass roof 2.5–2.8 metres (8–9 feet), and its pitch 0.8 metres ($2\frac{1}{2}$ feet). The glass side *l'*, *l'*, faces north. The printing-room should be $2\frac{1}{2}$ metres (8 feet) wide, and the glass roof as above; the door *a*, *b*, 1.25 metres (4 feet) wide, is in the middle in order to move the camera as far back as possible when we want to make whole-length portraits on plates 7″ x 9″. When we wish to be saving, the dotted parts *lp*, *lp* = 62 centimetres (2 feet) wide, may be left unglazed.

Fig. 8.

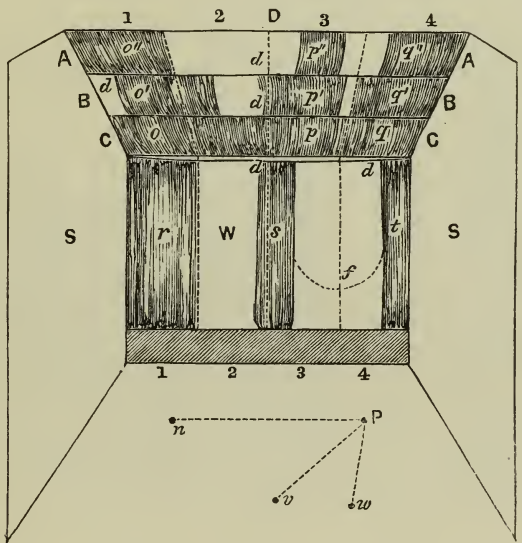


For the curtain arrangement for these small galleries, we recommend Schaarwachter's plan (Fig. 9). It consists of three hanging

curtains for the glass side *r*, *s*, *t*, which run on a single stretched brass wire *d*, *d*.

Such brass wires, six in number, are stretched along the glass roof; each two of these wires carry three curtains, *o*, *p*, *q*. Cords, rings and rollers do not exist. With the aid of a long stick the roof curtains *o*, *p*, *q*, may be separated, in such a manner that they cover it entirely, or they may be pushed together and openings of any desired size can be made. The like may be done with the curtains of the glass side

FIG. 9.



r, *s*, *t*. When we wish to exclude the light from the feet of the sitter, the lower part of the glass side is covered up, by fastening the ends of *s* and *t* together.

For short exposure the parts 1, 2, 3, of the side and roof are opened, and 4 remains closed. For good light, longer exposure and artistical illumination, section 3 of the side and 3 *C* of the roof are opened; with feeble light we also open 2 of the side and the section 1 *A*, *B*, and *C*; of course a few inches more or less make no difference. We can of course only give sketches here which the thoughtful artist may modify at pleasure.

SIZE OF THE ATELIER.

What *dimensions* shall we give the atelier?

We have to consider, first, another point,—*i. e.*, distance.

We need, for a picture of *carte de visite*, or for one of half size, lenses of different focal length, and also a different distance from the apparatus to the object. The longer the focal length of an objective, the greater must be the distance between the model and the camera. In a tunnel atelier this can be accomplished by extending the tunnel. In a north front atelier, where the apparatus stands in the glass-house, it is necessary that this should have the proper length, provided that we cannot remove the apparatus into an adjoining apartment.

The length of a glass-house, where no adjoining rooms are at the disposal of the operator, should not be less than 20 feet.

The smallest width, when we do not wish to be cramped in our operations, should be 10 feet. In such a room standing figures, for which the greatest distance is necessary, could be taken only of card size. For standing figures of larger size such an atelier would not be sufficient. For such figures in cabinet size at least 24 feet would be necessary, and for $8\frac{1}{2}$ by $6\frac{1}{2}$ plates at least 30 feet would be required.

For busts, etc., a shorter distance would suffice.

Groups, which besides the height extend in breadth, require still larger distances than standing figures, and want besides a corresponding width. An atelier 40 feet long and 20 feet wide would, however, answer almost all requirements. The height of the glass side we would recommend should not exceed 10 feet (Adam Salomon, whose light-effects are so much praised, has an atelier 8 feet high). The glass roof must ascend to the rear, like a desk, in order to shed the rain-water. I would recommend for a distance of 10 feet an ascent of 2 feet. The depth of the glass roof itself should be nearly equal to the depth of the atelier. The lighting of the shadows will thus be under perfect control by opening more or less the top curtains.

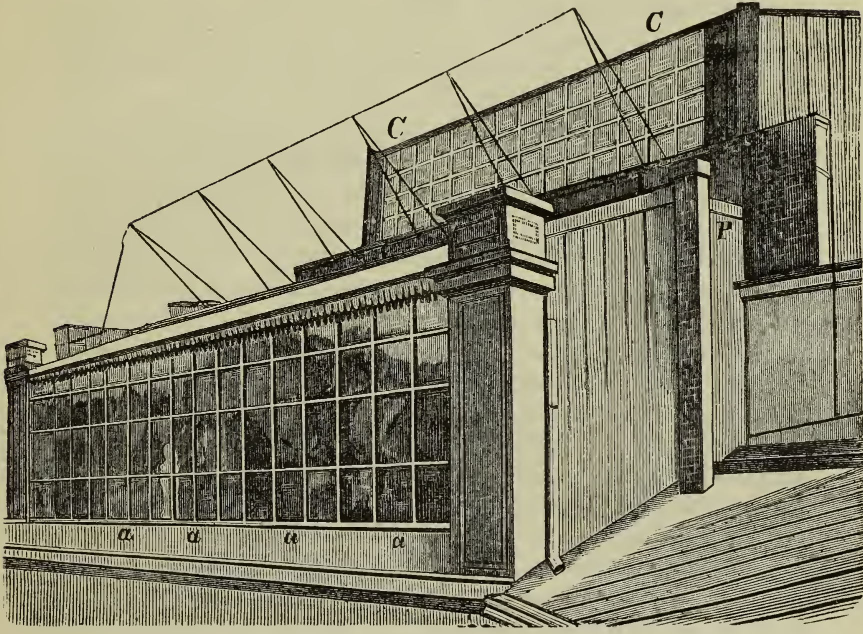
FORM OF THE GALLERY, THE GLASS-HOUSE, AND ACCESSORY ROOMS.

Fig. 10 gives the outside view of Milster's atelier in Berlin. It is 32 feet in length and 23 feet in width. Above, the iron rods are visible on which the awning for protection from the sun, is fastened.

In winter-time these awnings are unnecessary; not so in summer, when the sun, here in Berlin, reaches an altitude of over 70°. The great objection to awnings is that they very easily tear. Every storm of wind endangers them, besides they do not ornament the building. A more solid arrangement the author noticed in America, and it was described on page 20, vol. i, *Photographic World*. It consists of a succession of screens, *i. e.*, boards of any desired width, and of a length equal to that of the gallery; these are placed parallel to the gallery.

Each board can be turned around its axis, which rests on an iron support. If the gallery is longer than 20 feet, a central support will be necessary. On every axis of the boards is a crank connected with a rod. This rod can be fastened to the iron work in any position.

FIG. 10.



This arrangement admits of placing the boards in any inclination that is desired. On the 21st of June, when the sun has an altitude of 74°, the position of the boards would be almost flat. On other days, when the altitude is less, they are opened wider; in winter-time they may be placed vertically except in a snow or hail storm, when they are closed altogether to protect the glass. It is to be remarked that this arrangement excludes the sun's rays only when the sun is not too far east or west.

In summer-time, when the sun even goes northward, a side protection is needed for the western side. For this purpose an awning is preferable. To those who do not wish to employ this arrangement, we recommend to paste over the glass silk paper, or covering it with a thick starch paste. In winter-time, when top-light is more necessary, the starch film is removed with hot water. Other photographers employ white muslin curtains to dampen the top-light, and also dark-blue ones for the total exclusion of light. Still others em-

ploy ground-glass. The corrugated glass has proven very successful; it permits almost as much light to pass through as the plain glass, but disperses it so much that it does not dazzle any longer. The glass with cylindrical ridges should not be selected, but rather a glass in which the knobs are very close together. The sides should always be glazed with transparent glass.

Curtains.—The best system of all is that of Loescher & Petsch. The old system of Loescher & Petsch, as explained on page 19, is cheaper than the new one.

White and lace curtains are superfluous. The latter do not prevent the light from entering, but only modify it. The same effect is produced with dark curtains by narrowing the opening through which the light enters. We would remark, in conclusion, that the curtains must be carefully handled. In damp weather the cords should be slackened to prevent their snapping, and even the most perfect arrangement will still leave something to be desired.

The American ateliers are generally *very high*, and, in this respect, well suited for taking groups and drawings. For the taking of single portraits, however, they are inferior to low ateliers. We know very well that there are high skylights in America in which splendid single portraits have been made, but it does not follow by any means that the high skylight is advantageous for taking single portraits. We refer to what has been said previously on the subject.

Of the Glass.—For the glazing of the atelier a good and as nearly colorless glass as possible should be selected. It must be free from manganese. Glass containing the latter substance will in course of time turn yellow and obstruct, in a measure, the passage of the actinic rays. This is the reason why in many ateliers the light gets worse from year to year.

Blue glass is not to be recommended. Mr. Gaffield has shown that blue glass obstructs the passage of the chemical rays to a much larger extent than white glass.

Ground-glass is also sometimes employed for glazing the skylight. The roof of Adam Salomon's atelier, for instance, is glazed with this substance. It absorbs about 50 per cent. of light, while white glass will absorb only about 5 per cent.

To the photographer who does not know how to manage his curtains in order to produce the best effect, we would recommend to cover his skylight with ground-glass. It modifies and mellows the effect of too strong a front-light. Ground-glass also is advantageous to prevent reflexes of sunlight in certain parts of the atelier which are exposed to direct sunlight. Ordinary glass, however, by being covered with

a thick starch paste, will act similar to ground-glass. A wash of warm water will easily remove this covering. Hance's Ground-glass Substitute answers all the purposes of ground-glass.

To keep the glass clean on the outside is of great importance. When the rain does not perform this duty the glass should frequently be washed. A hose attached to the water-pipe is very serviceable for this purpose.

Ventilation.—Frequent change of air is necessary. For this purpose the atelier of the Academy is provided with four small windows, below the side light near the floor. Besides, the rear wall of the atelier is provided with four large openings at its highest point (ventilators).

Heating is best accomplished by iron stoves, and a good coal or wood fire. A heating material which gives out heat rapidly should be selected, as the glass cools off very rapidly.

Paint.—The walls of the gallery reflect a certain amount of light; this light falls on the shaded side of the model and illuminates it. When the wall is red the shadow will also be red, which can readily be seen by looking at the picture of a plaster model on the ground-glass of the camera, when the eye is protected by the focussing-cloth. But red light does not affect the sensitive film, neither does brown. The walls should therefore be painted light blue,—cobalt blue. This gives effective light.

For a description of reception-rooms, see the remarks on Messrs. Loescher & Petsch's atelier.

Printing-room.—About the arrangement of the printing-room we have spoken before. Loescher & Petsch have theirs under the gallery. In Fig. 10 we represent an arrangement that is much in vogue in high buildings. In this instance the printing place is above. It forms a smaller skylight, simpler in construction, and 10 feet high. The main gallery should be built of glass and iron; this is rather dear but solid. The printing-room may be made of wood and glass. The platform in front, p. 29, is for printing in the open air.

PRINCIPLES OF DISTRIBUTION OF LIGHT IN THE STUDIO.

Experience has demonstrated that in all constructions of ateliers the principle of excluding direct sunlight, and of working with the diffused light of heaven, is found to be the best.

The reasons for this we shall explain in the second part of this book.

To exclude direct sunlight the glass surfaces face the north as much

as possible, and to obtain the largest amount of diffused light the glass-houses are erected on the tops of high buildings, or in places where the horizon on the glass side is free from objects which would obstruct the light. In cities this is not always possible, and frequently a considerable portion of the vault of heaven is cut off from view. The light which is reflected from buildings is not always useless, but its intensity is a different one. Sometimes it is lighter (when reflected from a white wall) or darker, and this circumstance becomes an annoyance when the light is to be distributed properly by an arrangement of curtains.

Not only the quality and quantity of light is essential in the use of a glass-house, but also the direction in which it strikes the sitter has to be taken into consideration.

In the second part we shall give three photographic portraits as illustrations, taken with front-light, top-light, and side-light, and it will be noticed that front-light is the most unfavorable, while side-light is the most favorable. Leaving the explanation of this point for the æsthetic portion of our work, we will only mention that nobody should take a portrait exclusively with side-light, but that in the best portraits from the most celebrated ateliers this light predominates. From this standpoint we cannot advocate a construction like Monckhoven's, in which the front-light predominates; it would appear more useful when, as shall be explained further on, the side-light could be widened and the front-light made narrower.

For the better understanding of the distribution of light in an atelier, we must explain the main principles of illumination in a glazed space.

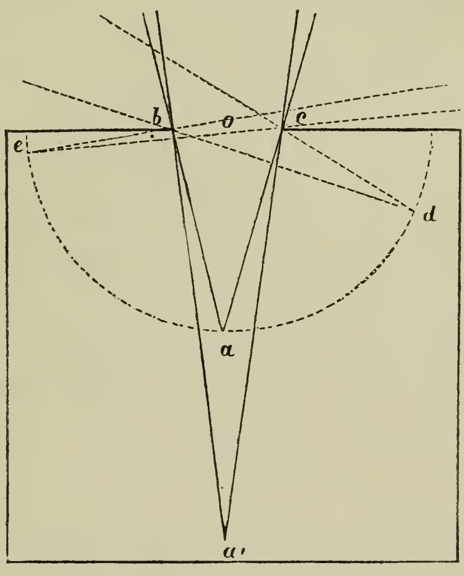
We take for instance a room which receives its light through a window from the clear blue sky. Experience teaches us that the light in such a room is very unequal in different places; the further an object is removed from the window the darker it will appear, and *vice versa;* but, besides the distance from the window, the position towards it becomes of importance. A point close to the window will appear darker than one equally far removed but opposite to it.

Let us explain the cause of this appearance. Excluding direct sunlight, the sky is the only source of light which illuminates the objects in the room, and an object will be lighter in proportion to the number of rays it receives from the sky.

Taking for instance the point a (Fig. 11), which is opposite a circular window, the latter receiving a cone of rays of the size of the diameter of the window. We take a second point, a'; this point is

illuminated by the cone *b*, *a'*, *c*, which is considerably smaller. Still more pointed appears the cone which illuminates the point *e*, and thus it is explained why *a* will appear brighter than *a'*, and *a'* brighter

Fig. 11.



than *e*. The opening of the cones of rays, or the angle which is formed by drawing lines from the point in question towards the window, gives us a criterion of its relative brightness. I call this angle the angle of light.

When we take a point on the wall containing the window, the angle will be reduced to a line, and would be absolutely dark if it did not receive light by reflection.

It is evident that not only the wall in which the window is, but also every other point in the room, receives this reflected light from walls, floor, and ceiling. Every point in the room, the wall with the window excepted, is struck by two different masses of light.

1st. The direct light of the sky, the quantity of which is proportionate to the extent of the effective spherical surface of the vault of heaven.

2d. The reflected light of the walls, &c., &c., the nature of which is more complicated.

Let us look aside for the present from the reflected light and con-

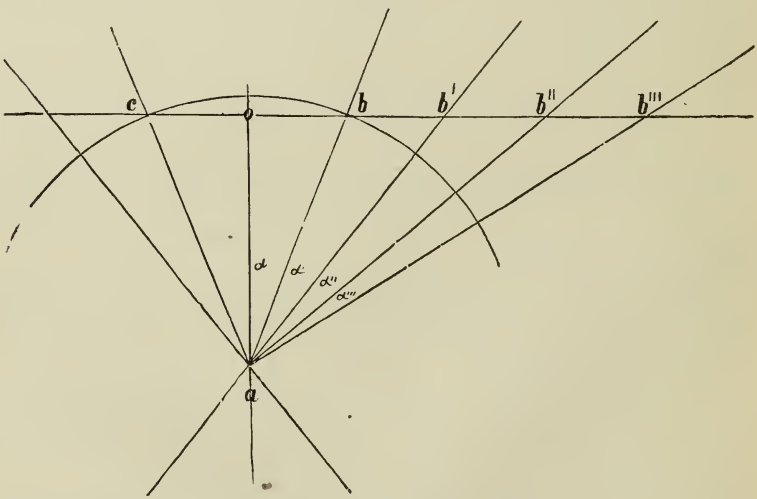
sider the action of direct sunlight. The illumination produced from this source we will call, for the sake of brevity, the *direct brightness.*

The direct brightness of a point in the room is, as has been explained above, dependent on its position to the window, and on the size of the latter.

For the better explanation of this point we will start from the plainest proposition, and consider the brightness of a point directly opposite to a small round window. The larger the window, the larger will be the angle of light. Suppose the angle of light should be small, then the brightness of a point will be proportionate to the surface of the window. In similar figures, the surfaces are proportioned as the squares of similar lines, and accordingly the brightness would be proportioned as the squares of the diameters of the windows.

A window twice as large, be it round or square, will give for the same point four times as much light, and one of three times the size nine times as much. With larger window openings the increase of brightness by increasing the opening is not so marked. We take for instance a point, a (Fig. 12), which is opposite the opening, c b, in

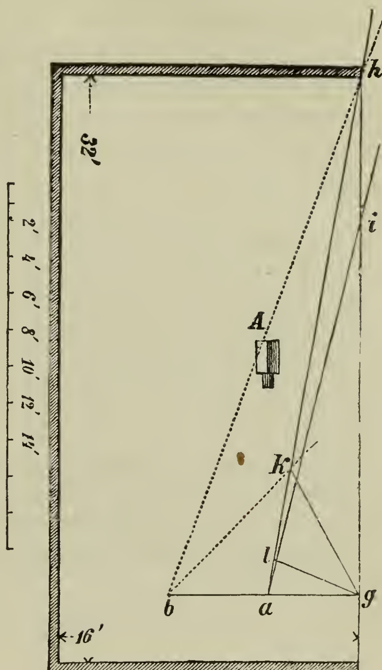
FIG. 12.



the otherwise darkened glass-house. Half the angle of light would be, in this case, α, and when we increase the opening successively to twice the size, $o\ b'$, or three times, $o\ b''$, and four times, $o\ b'''$, the angle of light at a will be increased by the piece α', α'', α''', which, as will be seen by the figure, increases less rapidly than the size of the window-opening. We can draw from this at once a practical conclusion.

If in a glass-house of 32 feet in length, a person, *a* (Fig. 13), is placed 5 feet from the glass side and 4 feet from the background, and the glass side is open from *g* to *h*, we will have a criterion of the amount of light which the person receives by constructing the angle *h*, *a*, *g*. The portion of the vault of heaven which is cut by the angle *h*, *a*, *g*, determines the brightness of the point *a*.

FIG. 13.



If the length of the atelier should be 24 feet instead of 32 feet, that is, if it terminated at *i*, then the brightness would be determined by the angle *i*, *a*, *g*, all other circumstances being equal. A glance at the figure will show that the angles *i*, *a*, *g*, and *h*, *a*, *g*, are not very different—*i. e.*, that in this especial case the extension of the glass wall by 8 feet beyond *i* (by the piece *i h*) would not secure any great advantages, particularly as the light which strikes the glass side *h i*, under a very oblique angle, is for the most part reflected.

As we increase the distance from the window we decrease the angle of light.

A simple mathematical consideration leads to the result that the brightness of two points, which are located opposite a window, *decreases at the same ratio as the distances from the window increase.*

When we remove an object twice as far from the glass side of the atelier, we must, in order to secure the same brightness, open the curtains twice as wide, in order that the light-giving glass surface be four times as large as when the object is near the glass side, or we must extend the time of exposure fourfold in order to secure the same result. When the window is very large the brightness will not decrease quite as rapidly with an increase of the distance—*i. e.*, at twice the distance the brightness will be a little more than one-fourth, at three times a little more than one-ninth.

From the above considerations we may draw a practical conclusion

and answer a question which of late has been asked quite frequently, namely: "*Which is the most practical, a high or a low atelier?*" But we have to answer another question first: For what purposes is the atelier intended?

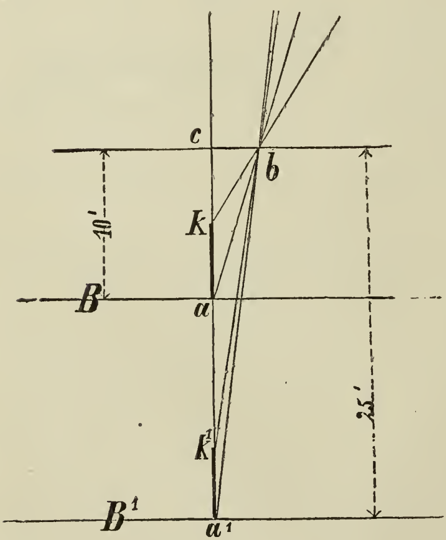
An atelier may be perfectly adapted to the taking of single portraits, while it may be unsuited to the taking of groups or reproductions, and *vice versa.* Ateliers like Reutlinger's or Adam Salomon's, are excellent for taking single portraits, while they are unsuited to taking groups.

The reason of this is easily explained. In copying large paintings or drawings we require a uniform illumination over the whole of the original, while with a single portrait the reverse is the case. The head, which is the principal object, should be lighter, while the other less characteristic parts should be kept in half shadow. These are artistic qualities which in a high degree are visible in the portraits of Adam Salomon, and less strikingly in those of Carl V. Jageman in Vienna.

If we should try to take a group under the same conditions of illumination, only one person would appear properly lighted, while all the rest would be in half shadow and scarcely visible.

To answer, therefore, the above question we must consider first the purpose for which the atelier is constructed; and I will take the simplest case first,—*the construction of an atelier for single portraits.*

FIG. 14.



Suppose we have an atelier (Fig. 14) about 25 feet high, and in it an object, for instance, a person, *a' k'*, 5 feet high. Above the person is an opening, *b c*, in the glass roof of a given size. The distance of the head from the roof would be equal to 20 feet, and the distance of the floor = 25 feet; hence the brightness of the two would be as 400 to 625 = 16 to 25, or nearly as 2 to 3.

Suppose, further, we have an atelier 10 feet high, all other condi-

tions being equal. In this case the head, k, would be 5 feet distant from the floor, and the feet, a, $=$ 10 feet; the brightness of the two would be as 1 to 4.

It shows how important these differences are. In the first case, in a bright atelier, the head receives only one and a half times as much light as the feet: in the second case four times as much. What is the consequence? In the former case we have slight contrasts of light and shade, while in the latter they are very strong.

In a portrait the head is the principal object; the head should receive the main light. A contrast of light and shade between hands and feet in the proportion of 2 to 3 is not sufficient to mark brilliant contrasts in the picture. A difference of 1 to 4 gives much more effect. From this standpoint a low atelier has the advantage for taking single portraits. As an example of such low ateliers I would mention those of Adam Salomon and Reutlinger in Paris.

The case is quite different when we take *groups* or *drawings*, where an illumination which is equally divided over the whole surface is desired. *High ateliers* are in this case desirable. But we can, in a low atelier, produce the same effect when the *glass roof* is sufficiently wide, or of a width equal to the group.

When, on the other hand, we wish to obtain in a high atelier the same effects as in a low one, we will do well to place the persons under screens or curtains, which are placed at a height of about 10 feet above them.

While explaining these principles we, for the present, do not take into account the light which is reflected from the walls, nor the amount of light lost by reflection in passing through the windows. Any one who has read the preceding directions attentively will find no difficulty in solving different problems in regard to the brightness of a given point in the atelier. For small openings of light it is easy to calculate the brightness of a point in the room according to the formulæ given hereafter, but with larger glass surfaces the construction of the angle of light will give the best criterion.

For this purpose a drawing of the atelier (or a part of the same containing the point in question, and the area of glass surface transmitting the light) is made in ground-plan and vertical section, and the angle of light is constructed both in the vertical and horizontal plane.

From the above principles a criticism on the construction of the atelier follows as a matter of course.

Let us take as an example the atelier (Fig. 13) which has a northern front. It is 32 feet long and 16 feet wide; it shows closed walls

and a glass front, *h g*. The scale is given. Suppose a person be at *a*, 5 feet from the window and 4 feet from the rear wall, the glass side to be open from *g* to *h*, or 28 feet. We will get the effect of the 28 feet glass side by constructing the angle *h*, *a*, *g*. Suppose we take instead of the long glass side, *g h*, an inclined one, *g k*, of only 8 feet in length. The angle, *k*, *a*, *g*, will be exactly as large as the angle *h*, *a*, *g*, *or the small glass side of only* 8 *feet will admit as much light as the large one, g h, of* 28 *feet in length.*

Even a glass side, *g l*, of only 5 feet in length, would give as much light on a person at *a*, and be unprofitable only in so far as seen from *A* (where the apparatus has been placed); a part of the field of view would be cut off by the edge *l*.

We have shown that for taking the picture of a person at *a* the large glass side of 28 feet in length can be replaced by a much smaller one placed at an inclination, the size of which need only to be 8 feet, without detriment to the brightness of the illumination. *What holds good for the side applies with equal force to the roof. The surface of* 28 *feet in length can be replaced by an inclined one of only* 8 *feet.*

When we construct an atelier with such a glass side and an analogous roof, we will have a space which apparently equals in brightness the large atelier of 32 feet in length.

Such an atelier would resemble the following figure (Fig. 15).

The parts not shaded are glazed; the others are dark; the apparatus would stand in the dark parts, *T, T;* the person would be at *a*, near the glass side. The depth of the glass roof we have taken at 12 feet. For single portraits this would not only be sufficient, but for most cases in excess, and only in exceptional cases the whole roof could be employed.

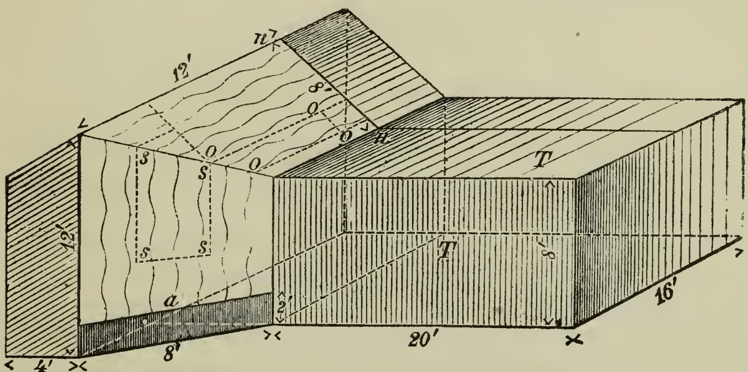
Starting from simple principles of illumination we have reached an atelier construction which has often been adopted, although in different proportions. It is the so-called *tunnel atelier*, and we have shown that for taking *single portraits*, observing the *explained conditions*, it answers every purpose in regard to the quantity of light as well as a large north front atelier. For amateurs and small photographers, but only for these, such a building would answer every purpose.

The best position for the side is due north. In this way the side light is, as the main light, most effectually excluded from the direct rays of the sun. The roof must be protected by awnings from the direct sunlight. Where the saving of room is an object, the depth can be reduced to 16 feet. Such an atelier would answer for single portraits, and would recommend itself on account of its cheapness; still it has disadvantages when compared with a north front atelier.

In the first place, the person always receives the light from the same side. In the above instance from the right, while an atelier fronting north admits of illumination from right or left by placing the person so as to face east or west.

This disadvantage is not of great moment. In all of Reutlinger's pictures the light comes from the right-hand side.

Fig. 15.



A greater disadvantage shows itself when the person is not, as we have proposed, seated near the glass side, but is removed from it.

Suppose a person is placed at *b* (Fig. 13), twice as far from the glass as *a*, we will see by drawing the lines *b h*, and *b k*, the light-effect which the two sides *g h* and *g k* will produce; and here it becomes evident that the angle *h*, *b*, *g*, is much larger than *k*, *b*, *g*, *or that for a point removed from the glass side the illumination is in a north front atelier much more favorable.*

In a tunnel atelier we are confined to the space in the immediate neighborhood of the light, while a north front atelier permits of greater depth, *and the latter gives not only a greater space for artistic arrangement, but also a decidedly better light for taking groups.*

The advantages of a north front atelier are easily understood therefore.

CHAPTER II.

SECTION I.

THE FURNISHING OF THE GALLERY.

In the previous chapter having become acquainted with the immovable objects of the gallery, we will now proceed to the consideration of the movable ones.

These will vary with the purpose to which the gallery is devoted. In a portrait gallery they will differ from the furniture of an establishment devoted mainly to copying, and portrait galleries are again furnished with more or less luxury, according to the standing of the public with which the artist has to deal, or to his own personal taste.

We will confine our remarks to those objects which belong to an atelier for the production of portraits, reproductions, and the taking of pictures of plastic objects.

The work to be performed in the gallery is of a twofold character.

1. Arrangement of the model.
2. Arrangement of the apparatus.

The arrangement of the object which is to be taken is sometimes very easy, as the placing on a board of a print to be copied. Sometimes, however, the arrangement may offer great difficulties; for instance, with a living object which has a will of its own and generally will offer some resistance, not to speak of the fact that it has to be placed in the most pleasing position according to its individuality; that it has to be properly lighted and must be brought in harmony with the surrounding objects, even if these should consist only of a few pieces of furniture. We must also take into account, that the optical apparatus must be in condition to take in the whole arrangement with the greatest possible sharpness and within as short a time of exposure as possible. The picturesque and the optical standpoint have both to be considered (very often the one or the other is overlooked).

The artistic standpoint will be fully considered in the æsthetical

portion of this work; at present we will only take the mechanical arrangements into consideration.

When I focus a lens sharply on any object, say, for instance, a person, I will find that other objects, back or at the side of the sitter, appear also in the picture, materially influencing the beauty of the same.

These are either entirely left out by placing the object in front of a monotonous gray or more or less dark wall, which is called the background, or the accessories are so arranged that with the main object they form a harmonious picture.

The backgrounds are either made of cloth (the so-called "background cloth," which is expressly woven for this purpose), or they are painted on canvas or shirting with oil-paint, which is laid on as homogeneous and dull as possible. The background stuff is best placed on a frame analogous in its construction to the frames of the painters, which can be tightened by means of wedges, as circumstances may require.

The background may be hung on rails, *E*, *E*, and the upper part provided with rollers, *R*, *R*, as is represented in Fig. 16.

Such backgrounds are easily pushed aside, provided the atelier is wide enough. The atelier must have as many rails as backgrounds, as every background has to run on its own rail.

Small ateliers require different arrangements. The background is placed on rollers and moved from place to place as required, or the background is not mounted at all, but rolled up like a curtain. All the backgrounds in Reutlinger's atelier are arranged as curtains. Six to eight such curtains, one behind the other, and parallel to each other, are placed at the spot where the sitter is placed. But the backgrounds suffer by being rolled and unrolled so frequently, particularly when they are painted with scenic or landscape effects. The wider the background the better it will be for the arrangement.

In regard to the employment of painted backgrounds full directions will be found in the æsthetical portion of this work.

For the suitable arrangement of the model other objects are necessary, according to the nature of the same, such as pillars, balustrades, furniture, curtains, &c. But most photographers do too much of a good thing. They have a complete furniture store in their ateliers. Eminent artists will get along with the simplest accessories. All such objects should be so arranged that they can be placed in position in the shortest time, and be removed again at a moment's notice without any noise or confusion.

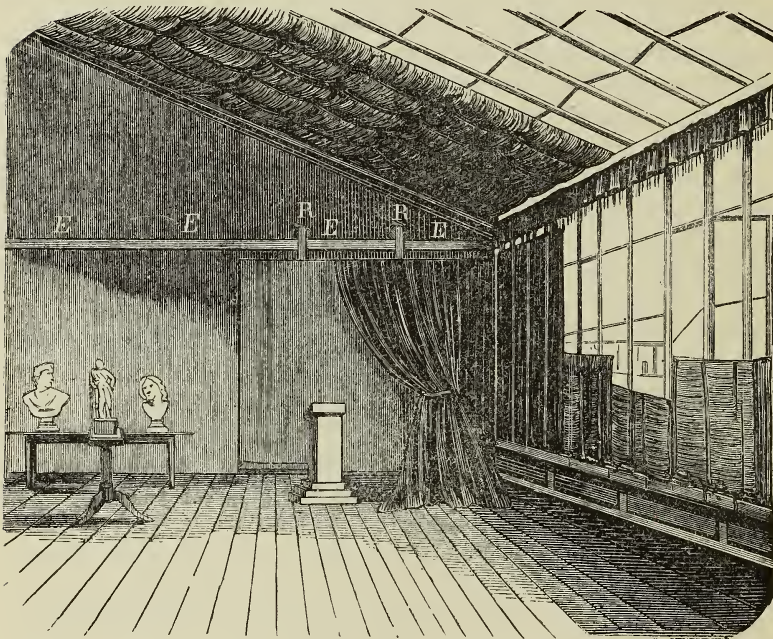
Generally the sitters are in a hurry and wish to be taken in a short

time, even if the time of the photographer should not be especially occupied.

With this simple arrangement, however, the original is not sufficiently prepared. An important point is that during the exposure perfect steadiness should be secured. With lifeless objects this is easily accomplished; they are placed on a solid foundation and fastened to it.

With a living model the case is entirely different. No one can sit

Fig. 16.

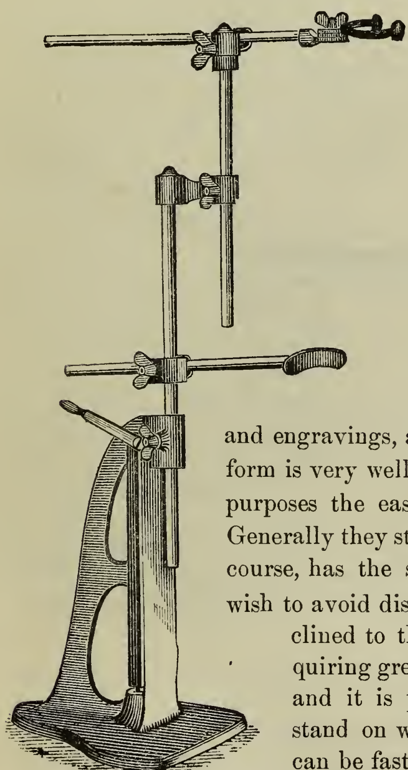


absolutely still. Every pulsation causes an imperceptible motion, and just at the moment of exposure, when the model is conscious that on his steadiness success depends, the spirit is most willing, but the flesh is weakest, particularly the most important part of all the flesh—the head. Nothing can prevent this evil but the use of the head-rest, against which the public obstinately protests, but upon the employment of which the photographer must just as obstinately insist. It should not be brought into use until all the other arrangements are finished, and everything is ready for the taking of the picture.

Then the "rest" should be adapted to the sitter, and not *vice versa*. The person who tries to force the sitter to the head-rest is guilty of "cruelty to animals," and is a sinner against good taste in the bargain. It is self-evident that this necessary evil must not be visible in the picture, a circumstance which often very sadly ties the hands of the photographer in making his arrangements.

Fig. 17 shows the construction of the head-rest generally used in the United States, and which is called "Wilson's Improved Rest."

FIG. 17.



For standing figures the rest requires great firmness, and the American pattern seems to be preferable, and all that is required. The joints should be frequently examined, and care should be taken that everything moves easy and without noise. Frequent cleaning and oiling is advisable. The American rests of less complicated and cheaper form are familiar to all, known as Scovill's, the Tuscan, &c.

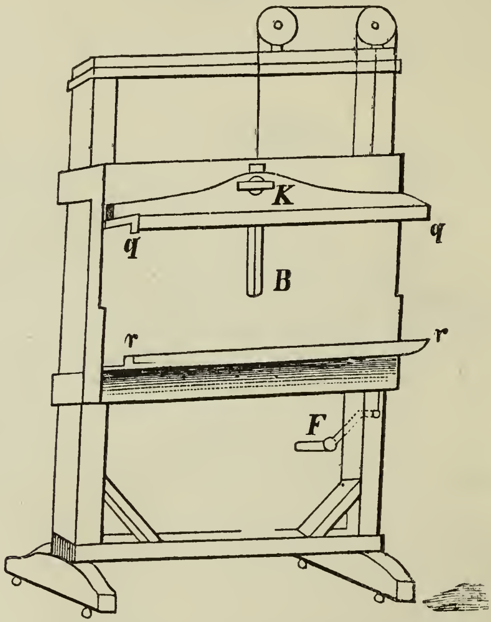
For the copying of paintings and engravings, an easel is generally used. The form is very well known. But for photographic purposes the easel would not be very practical. Generally they stand inclined, and the picture, of course, has the same inclination, and when we wish to avoid distortion, the camera has to be inclined to the same extent. For work requiring great exactness this is not sufficient, and it is preferable to employ a vertical stand on which a movable drawing-board can be fastened.

Fig. 18 represents such an arrangement. It consists mainly of the board, *B*, with the ledge, *r*, *r*, which serves as a rest for oil-paintings or drawing-boards. It can be moved in a vertical direction, and by the binding-screw, *K*, kept in position so that plates of different size can be firmly held. By a cord passing over rollers and worked by the handle, *F*, the whole is easily raised or lowered.

Drawings should be fastened to a drawing-board, which is placed on the ledge, *r*, *r*, and kept in place by the screw, *K*.

The whole apparatus is easily moved from place to place in the atelier wherever the illumination is the most favorable.

Fig. 18.



For copying plans, where absolute mathematical precision is required, the camera should be firmly connected with the stand which carries the original in such a manner that they cannot change their relative position to one another.

When the object has been duly prepared the arrangement of the optical apparatus is next in order.

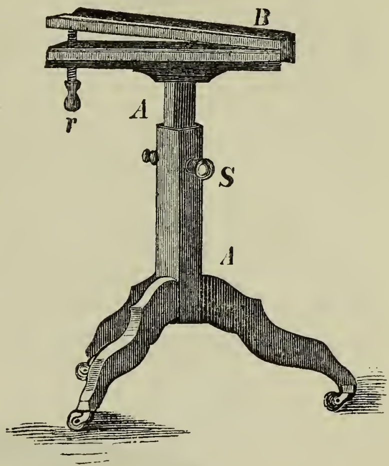
Accordingly as we wish to get larger or smaller pictures of an object, the optical apparatus has to be removed or brought closer to the original, and therefore it should be easily removable. Hence the apparatus is generally placed on a stand. But as the different objects vary greatly in their height and breadth, the stand is supplied with a vertical and horizontal motion.

The construction of the stand is more or less massive according to the size and weight of the apparatus.

Fig. 19 and Fig. 20 show two of the forms most generally in use. Fig. 19 is better adapted for lighter cameras, while Fig. 20 (the

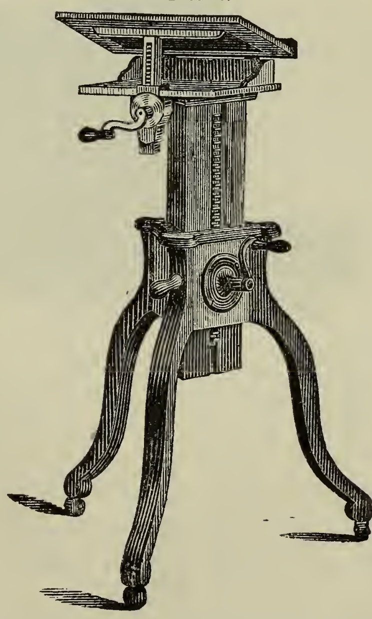
American Optical Company's "*Perfect*" camera-stand) answers for heavier ones. With the latter the vertical movement is accomplished by a handle and rack movement. The binding screw is to keep the apparatus in any given position. The inclined position of the board is generally only employed in portraiture. It enables the operator to secure more nearly equal sharpness to the whole figure. The stands with rollers require a point which is driven in the floor to give them steadiness. In bringing the stand in position the beginner should take notice that in moving the bar in a vertical direction the picture on the ground-glass will move in the same direction.

FIG. 19.



Iron stands have also been introduced; but generally these are too heavy and ruin the floor or the carpets. Arrangements have also been made by which the rollers can be fixed in position and give perfect stability to the apparatus.

FIG. 20.



SECTION II.

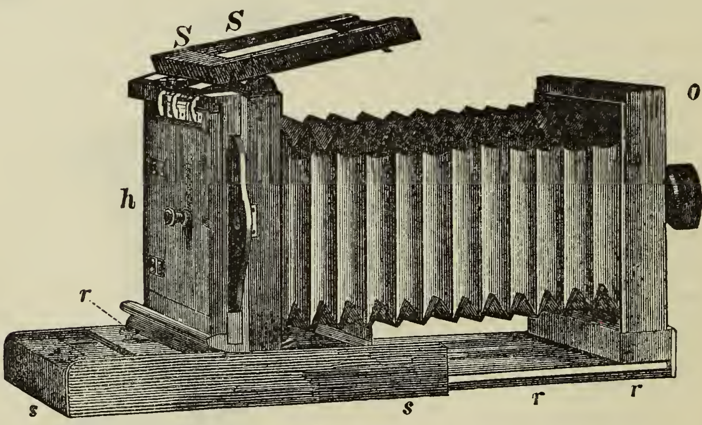
THE CAMERA.

The camera, in order to secure exact focussing, should be connected with the stand as closely as possible, so that the position will not change. A camera which is merely placed on the stand, is easily moved and often gives rise to faulty pictures. This is particularly the case with light instruments. Heavy ones will stand firm by their own weight.

The photographic camera is one of the simplest optical instruments. It consists of a box which is often formed of a pair of bellows only. The end, which is turned towards the object, is furnished with a lens called the objective, and the other end is provided with a plate of ground-glass, which latter can be moved nearer to or further from the objective. The box or the bellows serve to produce a dark space. It is necessary that this should be absolutely dark, a circumstance of which one must satisfy oneself in buying a new instrument by placing the head inside the camera, excluding all outside light by a cloth, and looking carefully for cracks which might admit the light.

To obtain a sharp picture the plate of ground-glass is brought more or less near to the objective. For this purpose the back part of the camera, *h*, can be provided with guides, *s*, *s*, which run in grooves parallel to each other. The screw, *r*, serves to fix the ground-glass at the desired distance from the objective.

Fig. 21.



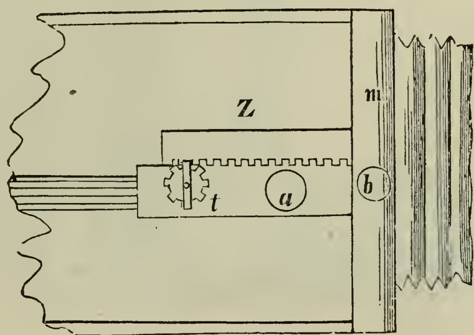
When the part, *h*, is brought very near to the objective, the projecting board, *s*, will prevent the operator from bringing his face very closely to the ground-glass, and make perfect focussing rather difficult. It is more convenient to pull out the front part, *r*, which moves in grooves inside of *s s*. When the picture has been focussed tolerably sharp on the ground-glass, the finishing touches are given by either the rack movement on the lens itself, or by a rack movement at the rear end of the camera.

The screws *a* and *b* (Fig. 22) should be loosened; the back part, *m*, which carries the ground-glass, is now moved; *a* is screwed tight, and

with the rack movement, *Z* and *t*, the fine adjustment is made. Finally, the whole arrangement is fixed by tightening the screw *b*. In this way our German camera boxes are made.

The English cameras, to facilitate focussing, are provided with an endless screw, which moves the object-board *O* (Fig. 21). The screw is worked by a crank. This arrangement is very handy, but admits only of limited motion.

FIG. 22.



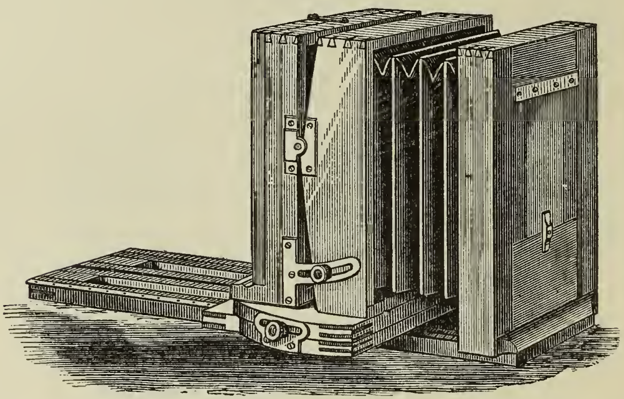
A better arrangement than any of these is applied to the boxes made in New York by the American Optical Company. The front part of the frame of the camera box is made fast to the platform, and the focussing is done with the back part of the frame, which runs on metal guides attached to the sides of the platform. An approximate focus is thus obtained, and the exact focus is secured by means of a short focussing screw which works in a groove in the centre of the platform. A clamping screw fastens the whole rigidly in place when the focus is obtained. This arrangement may be seen in Fig. 29.

When the focussing has been accomplished, the ground-glass, *S S* (Fig. 21), is turned back and in its place the plate-holder is pushed, carrying the sensitized plate. The sensitive plate must occupy exactly the same position which the ground-glass has occupied before, or the picture will lack sharpness.

To find out if a camera works correctly in this respect, the lens is removed and through the hole a rule is introduced. The distance between the ground-glass and the front of the camera is noted down; next a plate-holder with a plate of glass is put in position; the shutter is opened and the distance between the glass and the front of the camera is noted down. When the two exactly correspond the plate-

holder is correct. Sometimes the ground-glass admits of slight movements by means of the so-called double swing-back. This motion is of advantage for the sharp focussing of such objects which have an inclined position to the axis of the instrument.

FIG. 23.



The swing-back is a great help in focussing accurately and in getting the correct figure on the plate without trouble, and is applied to the American Optical Company's boxes. Very often the figure is too high or too low upon the plate. A vertical motion of the back of the camera, one way or the other, will obviate this at once. So when more or less of one side or the other is needed in the picture a lateral motion or swing at once secures it. The back is then secured in place by the clamps and screws as shown in Figs. 23 and 29.

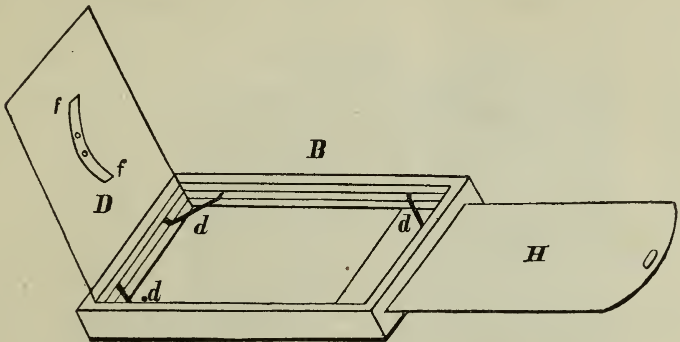
The construction of the plate-holder is easily understood from the cut (Fig. 24). The sensitive plate is placed in the frame, *B*, and rests on the silver wires, *d d*. The lid, *D*, is now closed and the spring, *f*, presses firmly on the plate and keeps it in position. The shutter, *H*, remains closed and is only opened when the plate-holder has been placed in the camera and everything is ready for the exposure.

The wood of the holder is apt to become warped, being frequently moistened by the drippings of silver solution from the plate. The wood should be well oiled and varnished, and the different pieces should be joined crossways, one upon the other, and all the different parts well dovetailed together.

In Europe the shutters of large plate-holders are frequently pro-

vided with hinges, which admit of their being bent over; the American plan, where the shutter can be removed entirely, is preferable.

Fig. 24.



In the bottom of the holder a little cavity is placed, made watertight with pitch, to collect the silver drippings. Such a holder, unless it is carefully wiped every time it has been used, is liable to get spoiled by the silver solution entering the wood. The solution decomposes in the wood, and the products of decomposition are by capillary attraction carried to the collodion film, where they cause moss-like spots. The author, to avoid this, places the lower part of the plate-holder for five minutes in melted paraffin. This preserves them for years just as good as asphalt, with which plate-holders are often coated. It has also been recommended to paint the corners with negative varnish. Such a paint, however, would have to be repeated monthly.

Fig. 25.

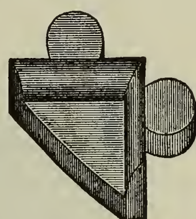
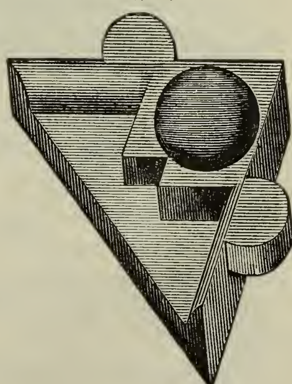


Fig. 26.

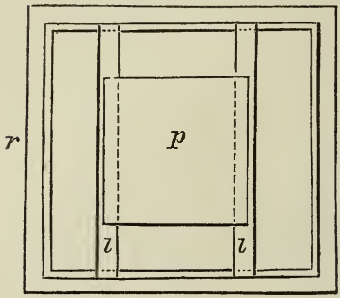


The sizes of the holders vary considerably. In order to place plates of different sizes in the holder, they are furnished with inserting frames or "kits," which are provided with silver wire corners on which the plates rest.

I must again express my preference for the American boxes. The holders in them are supplied with improved glass corners, which are imper-

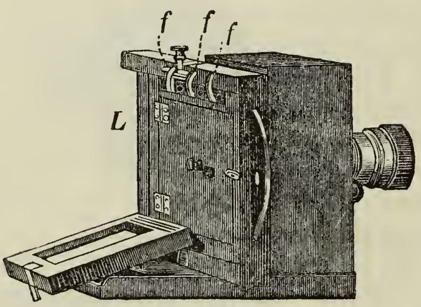
vious to all action of the solution. Moreover, they are made of such a shape (see Figs. 25 and 26) that they bind the wood frames together so that it is impossible for the solution to get to the wood at all. Another advantage is the *reversible* corner (Fig. 26), which is familiar to all my American readers and need not be described here. These corners are far preferable to the silver wires. In place of these kits Mr. Benecke, in St. Louis, takes two glass rulers, *l l* (Fig. 27) which he places into the plate-holder, and on which a plate of any size can be put. Instead of placing the plates flat on the rulers, the latter may be provided with glass ledges, which are cemented to the under side with shellac, and the plates rest on these ledges.

Fig. 27.



Then there are the sliding holders, by which two, three, or more pictures can be taken on the same plate. On a broad board, *L*, *L* (Fig. 28), the holder moves in a groove in a horizontal direction. Three points, *f*, *f*, *f*, which catch with springs in notches, serve to keep the plate in a fixed position. The so-called "carte de visite camera" is so constructed.

Fig. 28.

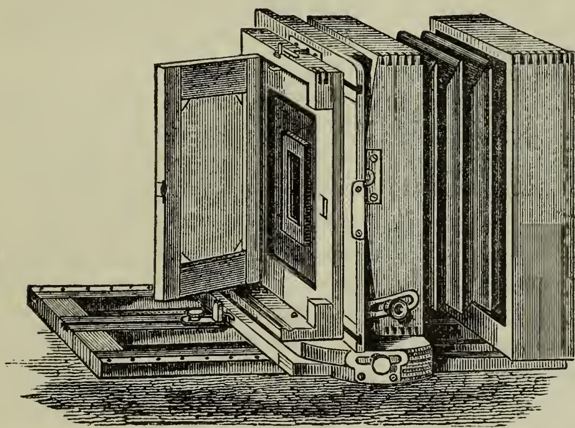


For beginners it may be necessary to call attention to the fact that the camera must not be moved while the ground-glass is removed, and the plate-holder put in its place, and that the shutter must not be pulled until the holder is in its place. When all this has been done the cover is removed from the object-glass, but without shaking the camera.

Alluding to the American boxes again, Fig. 29 represents another kind of sliding box, and is known in the American Optical Company's catalogue as the "Imperial" box. In it the frame holding the plate-holder is made to slide laterally on a platform, which platform again may be moved vertically, proper catches being furnished to fasten both in position. In this way the plate is moved over the

field of the lens, allowing the operator to take several positions on one plate and even to change the sizes. Internal diaphragms are supplied to effect the changes in size.

Fig. 29.



SECTION III.

USE AND CONSTRUCTION OF THE CAMERA-TUBE.

The objective consists of a tube containing either single or compound lenses and stops. The size of the tube depends on the size of the lenses, the distance which they require to be apart, and the position of the stops.

Fig. 30 shows a very general mode of mounting. It represents a Busch portrait objective with separate central stops, *D*, *D*, which are placed in the slit at *X*; the flange, *R*, is screwed to the front of the camera-box. The back lens is at *H*, and the front lens at *r*. With the cap, *C*, the lens is covered or uncovered. By the rack and pinion movement, *T*, the fine adjustment in focussing is made. The front piece, which is screwed on at *r*, serves not only for carrying the cover, but excludes also side-light. The fault of this construction is the *detached stops*, which easily get lost.

Fig. 30.

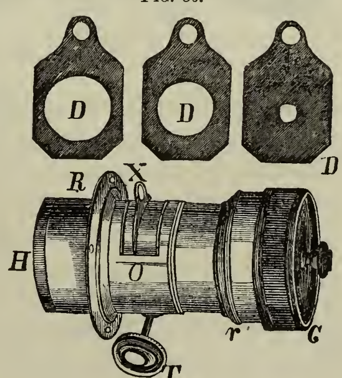
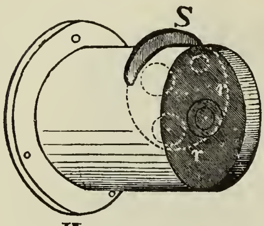


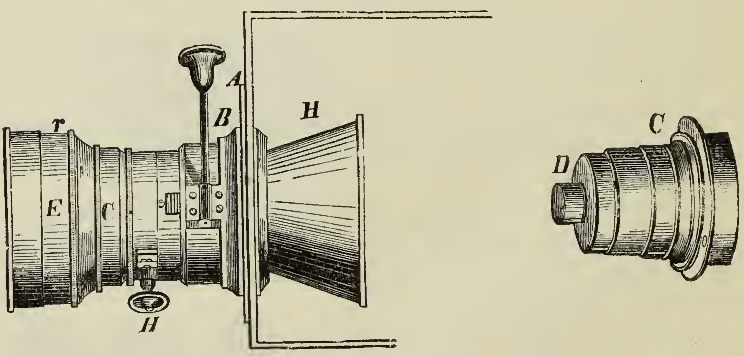
Fig. 31 represents a landscape tube, by Ross, without cover. The lens is placed at *H;* the stops are permanently fixed and consist simply of a disk, *S*, with different sized apertures. By turning the same, the dimensions of the stop are easily changed; a black disk, *r*, with an opening equal to the size of the largest stop, closes the tube in front.

FIG. 31.



There are other tubes in the market, where the front lens can be used as a landscape lens. To this class belong the "cone" objectives, as shown in Fig. 32. The back lens, *H*, is as large as the front lens. This lens has a movable mounting, and can either be entirely drawn out or brought more or less closely to the other lenses, to lengthen and shorten the focus. The stops consist of rings, which are placed inside the tube at *D*, the front part, *C*, having been previously removed. This front part, by being screwed in a reversed position to the mounting, forms, when all the other parts are removed, a landscape lens at *D*, with stops and cover.

FIG. 32.



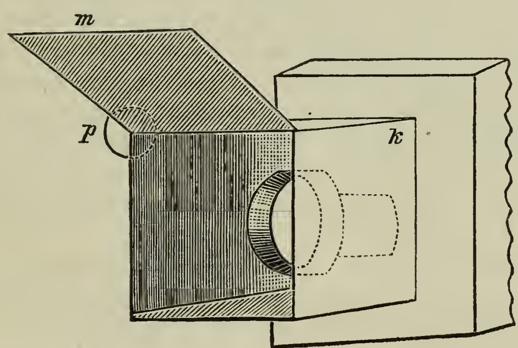
The inside of the tubes should be perfectly black. When these surfaces reflect light, we will have spots on the plate at once. The tubes are generally screwed to separate boards or fronts, which are easily detached from or placed on the camera.

For the purpose of exact adjustment of focus, the stop with the largest opening is generally used. Only a part of the picture becomes sharp, and to remedy this, stops with smaller openings are introduced after the focussing has been done. When we wish to extend the sharpness as far as possible to the margin of the plate, we use a

very small stop. To see the image on the ground-glass more distinctly, a cloth, which is thrown over the head, is of advantage. A focussing-glass enables the operator to focus with much more certainty. To what degree of fineness the ground-glass has been ground is of much importance, for all imperfectly ground glass is frequently a source of error. Focussing is much easier with an objective giving fine illumination and in clear weather. In cloudy weather, and with lenses that do not have much light, it is sometimes rather difficult.

A precautionary measure, which, particularly in bright weather, should be observed, is the exclusion of all extraneous light from the objective. Every objective acts not only as a lens, but also as a window, and admits a great deal of diffused light, and this causes either fogging of the whole plate or interferes with the brilliancy of the picture. This diffused light is easily discovered by placing the head under the focussing-cloth, the ground-glass having previously been removed. The camera, with lenses of large opening, will appear very light. To exclude this foreign light a box (Fig. 33) is used which

Fig. 33.



surrounds the objective, and has only an opening in front, which can be opened and closed by a lid, *m*.

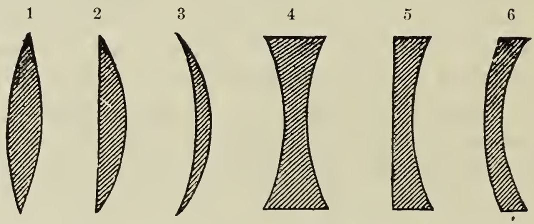
Claudet and Bingham place the whole apparatus in a kind of tent which moves on rollers. The arrangement appears very clumsy.

CHAPTER III.

DESCRIPTION OF PHOTOGRAPHIC OBJECTIVES (TUBES) AND LENSES.

The form of lenses which are used in the optical department of photography will be explained by the following figures.

Fig. 34.



Numbers 1, 2, and 3, are thicker in the centre than on the margin. They are called convex lenses. Numbers 4, 5, and 6, are thinner in the centre than on the margin, and are called concave or dispersing lenses. We distinguish biconvex (No. 1), plano-convex (No. 2), concavo-convex (No. 3), also biconcave (No. 4), plano-concave (No. 5), and concavo-convex (No. 6). The connecting lines of the centres of the spherical surfaces, which form the surfaces of the lenses, are the axis of the lens. Any plane which is placed through the axis of the lens, is called a main section.

The collecting lenses have, within certain limits, the faculty of collecting to a point the rays which proceed from a point, provided that these points are situated on the axis or near it, and provided that the angle which the rays form with the axis is not too large. When, under these conditions, a bundle of rays, parallel to the axis of the lens, falls on a lens, the rays will be united in a point back of the lens, and this point is called the focus, and the distance between the focus and the lens is called the focal distance. The rays which proceed from a point on the axis or near to it, are also united in a point back of the lens, and it is easy to calculate its distance from the lens. If, for instance, the focus is $= P$, the distance of the point of light $= a$, and the distance of its image $= x$, it follows that—

$$\frac{1}{x} = \frac{1}{P} - \frac{1}{a}$$

$$X = \frac{ap}{a - P}$$

For instance, a lens has a focal length of 10 inches and is 120 inches distant from an object, then—

$$a = 120 \text{ inches}, \ P = 10 \text{ inches};$$

hence—

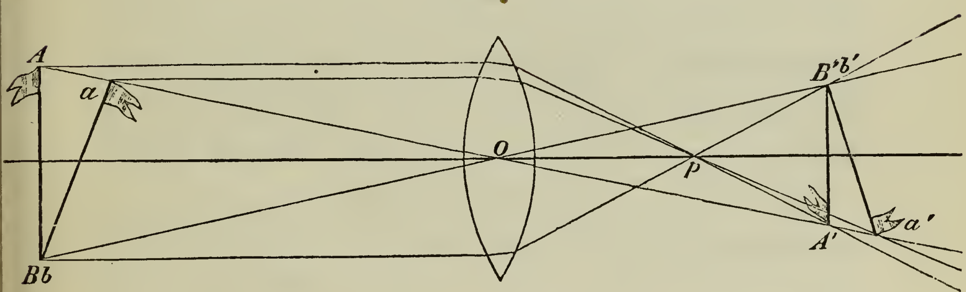
$$\frac{ap}{a-P} = \frac{120 \times 10}{120 - 10} = \frac{1200}{110} = 10.9 \text{ inches};$$

hence x is *i. e.*, the distance of the image from the lens = 10.9 inches. When the distance, a, is greater than 100 times the focal length, the image and the focus will nearly coincide.

When we direct a lens to very distant objects, we will get in the focus of the lens a small reversed image of the object.

When the object is brought nearer to the lens, the image will appear further removed from the lens. The exact spot is easily found by construction and calculation.

FIG. 35.



When we take the lance, A, we will find that all the rays proceeding from it, which travel parallel to the axis, will pass through the point, P. The rays which pass through the optical centre, O, of the lens do not change their course. The point where the rays proceeding from a or b cross each other determines the location of the image a', b'. When lens and object are parallel to one another, the image will also be parallel. When the object is inclined to the lens, the image will also be inclined, but in a reversed position.

These circumstances must be well observed in focussing with the camera obscura. The lines a, o, and b, o, which pass through the optical centre of the lens are called side axes in regard to the points a and b. All objects, the distance of which is more than a hundredfold the length of the focus, will form their image in the focus of the lens. When we move the lens closer to the object, the image will

move out of the focus, and when we move the lens still closer, and to within twice the length of the focus, the image will also be removed twice the length of the focus from the lens or object, and the image will be equidistant from the lens in opposite directions. When we go still closer, the image will remove still further from the lens, or more than twice the focal distance, and more than the distance of the object itself. The size of the picture depends on its distance from the lens. When the same is $= x$ the distance of the object $= a$ its size $= G$ then the size of the picture will be

$$= \quad \frac{x}{a} \quad G \quad \frac{P}{a—P} \quad G.$$

Hence the image will become larger as we approach closer to the object. Hence, also, we can make larger or smaller pictures of the same object by bringing the optical apparatus closer to, or by removing it further from, the same.

When the object is removed further than twice the focal length of the lens, its image will be less than the "natural size." When the distance of both is equal, or the object is twice as far removed from the ground-glass as the focal length, then the image will be of equal size with the object. *This fact is important in copying when a copy is to be made of the same size as the original.* The camera has to be drawn out to equal the distance of the object. When the object is moved still closer, we will get magnified pictures.

We can, therefore, with any lens, make larger or smaller pictures of the same object, and it would appear as if we could with a lens take pictures of any size to suit our pleasure. This, however, is not the case, as a lens, *similar to our eye*, can only take in a limited field of view at one time.

When we close one eye we overlook with the other a field of 90° circumference of angle, but we must turn the eye a little. So, also, every lens takes in a limited field only, which is called its field of view. When we move a photographic apparatus far away from the model, the whole figure, of a person, for instance, will appear in the picture. When the apparatus is moved closer, the proportions become larger; we no longer see the whole figure, but only three-fourths of it; and when we go still nearer, the head and chest only will appear.

Large objects, when they are wanted entire in the picture, should be far removed from the camera. But of such objects only small pictures can be made.

With the increase in the length of the focus, the distance of the

object from the lens remaining the same, the size of the picture will increase, and hence we select for large pictures lenses of long focus. When a is the distance of the object, G its size, p the length of focus, x the distance of the picture, then the size of the picture is B—

$$B \quad = \quad G \quad \frac{p}{a-p}$$

When the distance is very great, then—

$$B \quad = \quad G \quad \frac{p}{a}$$

i. e., the sizes of the pictures are proportioned as the focal lengths.

A lens of 7 inches focus is placed opposite to a person 5 feet high at a distance of 8 feet, then the size of the picture—

$$B = \frac{5 \text{ feet} \times 7 \text{ inches}}{8 \text{ feet}} = \frac{60 \text{ inches} \times 7 \text{ inches}}{96 \text{ inches}} = 4\tfrac{3}{8} \text{ inches.}$$

The field of view of a long-focus lens is, when the proportions of the radii are equal, no larger than that of a short-focus lens.

The production of pictures by a lens proceeds only under certain conditions in a regular way, which conditions have already been indicated above, and which become still more easily understood by the mathematical development which is given with it.

1. That the rays strike near the axis.
2. That they form only a small angle with the axis.
3. That they are monochromatic, or that they all possess the same index of refraction.

These conditions can easily be maintained in telescopic or microscopic lenses, but it is much more difficult with a photographic lens. In the latter the rays form very often a considerable angle, sometimes as large as 45°, and this gives rise to a whole line of errors, which only partially can be overcome by optical means. To these errors belong—

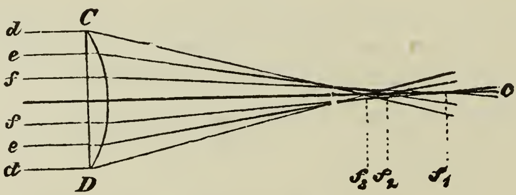
1. SPHERICAL ABERRATION.

When a single lens (a so-called landscape lens) is attached to a camera, and when we remove all the stops, we cannot obtain on the ground-glass a picture which can be called absolutely sharp, for such will always show blurred and ill-defined outlines. The picture, however, will become instantly sharp when we cover the front of a lens with a disk in the centre of which a hole has been cut, or in other

words, a stop. The cause of this want of sharpness is the uneqal refraction of the marginal rays as compared with those of the centre. The margin of the lens is, so to speak, a prism with a much stronger refracting angle than the centre. As the dispersion which the rays suffer increases with the refracting angle of the prism, it follows that the marginal rays will intersect the axis nearer to the lens than the central rays.

The focus of the marginal rays will, for instance, be in f^3, while the focus of the central rays will be in f^1 (Fig. 36).

Fig. 36.



Hence, if the ground-glass has been placed at f^1, the marginal rays, which have intersected the axis at f^3, will form a circle of dispersion. The diameter of this circle is called the transversal or lateral aberration. It is easily understood that this must be different in two lenses of *equal opening* and *different focal length*, and it must be the larger, the shorter (with the same opening) the focal length is. And it is also easily understood that with two lenses of *equal* focal length and *different* opening, the transverse aberration will be largest with the largest opening.

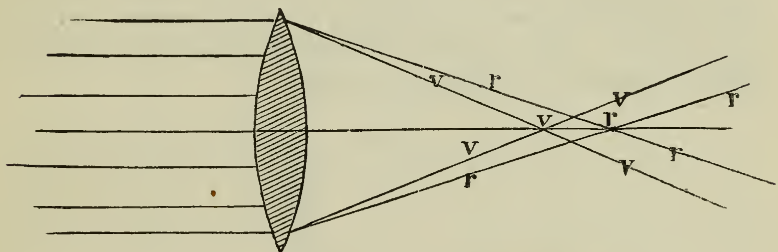
2. CHROMATIC ABERRATION OR DISPERSION OF COLOR.

The white light suffers in its passage through refracting mediums, not only by the refraction, but also by the dispersion of color, the cause of which is that the apparently monochromatic white light consists of rays of different quality, which partly distinguish themselves by their different effects on the retina and chemicals, and partly by their different refractions. Red has the least refraction; violet the greatest. The dispersion of color is most beautiful in the passage of white light through a prism, and then it gives rise to a colored band—*the spectrum*—in which the seven principal colors, violet, indigo, blue, green, yellow, orange, red, are distinguished. As a lens, however, is analogous to a system of prisms, such a dispersion of color must necessarily also take place in the passage of white

light through a lens, and as violet light is more refrangible than red, it follows that the violet rays will intersect the axis closer to the lens (after having passed through it) than the red.

Hence, when a bundle of parallel rays of white light passes

FIG. 37.



through a lens, the rays will not, after having been refracted, be united in a single point, but will, according to their different refrangibility, be placed at different distances from the lens on the axis of the same. The violet ones being the nearest to the lens, the red ones the farthest, and instead of having a single point, the focus, which would result with the employment of a monochromatic light, we will have a line of differently colored foci. (See Fig. 37.)

This error is overcome by the employment of two lenses, which are made of different kinds of glass (crown and flint). Nearly every photographic lens is made of these two kinds of glass; but even with one kind of glass, by suitably selected forms of lenses, the chromatic aberration can be tolerably well avoided, as is the case with the Zentmayer lens. With a good lens the focus of the indigo blue and yellow rays should coincide; if this should not be the case the image of the chemically active rays would fall in a different plane from the visible image, the picture will lack sharpness in spite of exact focussing. It is said such a lens has a chemical focus; further on we will state how a lens is tested for chemical focus.

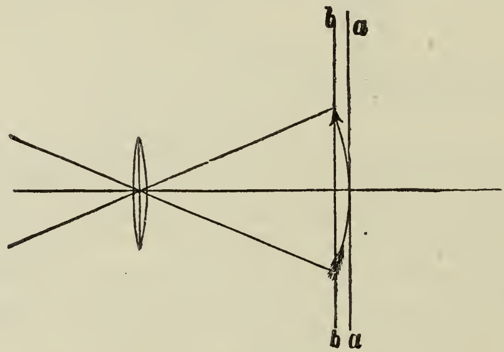
CURVE OF THE SURFACE OF THE PICTURE.

When a camera with any kind of an aplanatic lens is sharply focussed on an object, it will be noticed that it is not possible to get all the different parts of the picture sharply defined on the ground-glass at the same time. It is either sharp at the margin and poorly defined in the centre, or *vice versa*. This error is not caused by spherical aberration, for it occurs with all perfectly aplanatic lenses—that is,

lenses which have been corrected for spherical aberration; but the cause of it is the curve of the image.

The picture does not lie on a plane like the ground-glass but on a more or less curved surface, and by moving the ground-glass, only that part of the picture will appear sharp which touches or intersects the ground-glass. The arrow in Fig. 38 represents such a picture. When the ground-glass is placed at *a*, *a*, only the central part will appear sharp. When we place the ground-glass at *b*, *b*, only the points of the arrow will appear well defined.

FIG. 38.



These errors are avoided by suitable curves in the lenses, by combinations of lenses, and by stops.

DISTORTION.

When we focus, with a single lens with front stops, sharply on a square, *A* (Fig. 39), the resulting picture will not appear as a square, but with curved sides, almost as a barrel, *B*. The lines are curved outwards. When we substitute a lens with the stop in the rear, the curves will be reversed, as in *C*.

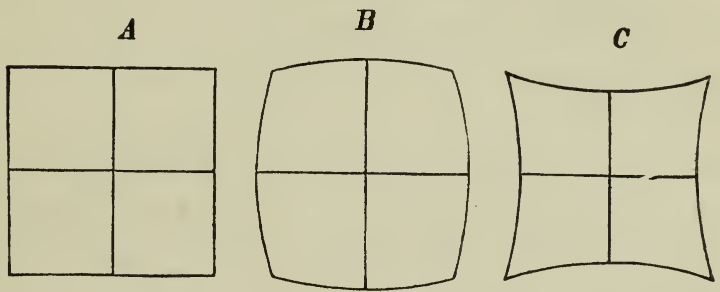
This is the case with all single lenses, but not always to the same extent. It is based on the fact that the marginal rays of the field of view strike the lens under a larger angle than the central rays, and consequently suffer a greater refraction.

But in this refraction, according to the position of the stops, the marginal rays are either brought nearer to the centre of the field of view, as is the case with a front stop, or they are removed from it, as is the case when the stop is placed behind the lens.

This distortion becomes more prominent with the increase in the

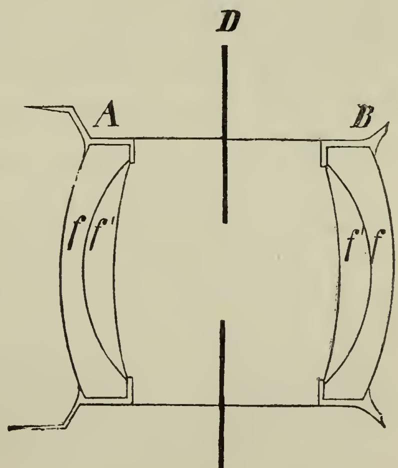
size of the field of view. It is particularly annoying in copying drawings, or taking architectural views. When single lenses are used for this purpose, the central part only can be employed. The distortion is dependent on the form of the lens. Amongst all the

Fig. 39.



simple forms of lenses, the meniscus lens, when its concave side is turned towards the object, shows it the least. It increases rapidly with a plano-convex lens, the plane side turned towards the object, and still more so with a biconvex lens. With single lenses the distortion can be reduced to a minimum by giving the proper form to the glass, but it never can be avoided entirely. This is only possible by a combination of lenses with so-called central stops. Imagine two lenses, *A*, *B*, at a certain distance from one another, and between the two, in the centre, the stop, *D*. In regard to the front lens this arrangement will act like a back-stop, and will cause the distortion noticed at *C* (Fig. 39), while with regard to the second lens, it will act like a front-stop, and cause distortion similar to *B*.

Fig. 40.



But as both distortions are in opposite directions, they will balance each other, and the result will be a correct image like *A*.

Such double objectives with central stops are the Globe, Zentmayer, Ross Doublet, and the new Aplanatic lenses by Steinheil.

The portrait tubes of Petzval are similarly constructed, but as the lenses are very unequal, a little distortion remains.

ANGLE OF VIEW, ACTINIC POWER, AND DEPTH OF FOCUS OF A LENS.

By the term that a lens has great actinic power, we mean its capability of giving a more or less bright picture. This depends—1, on the surface of the lens; 2, on its focal length; 3, on the loss by reflection and absorption which light suffers in its transit through the body of the glass.

The larger the surface of a lens the greater will be the quantity of light which it is capable of receiving. However, the surface contents are proportioned to the square of the diameter, or, as it is generally called, the opening. Hence, the amount of light of two lenses will be proportioned, other things being equal, as the squares of their openings.

When the focal distances of the lenses are different, they will give of the same subject pictures of different size. When, for instance, a lens of 6 inches focus gives of a man a picture of 3 inches, then a lens of 12 inches focus will represent a man as 6 inches high in the picture. The quantity of light which proceeds from the subject and falls on the lenses is necessarily the same, provided the openings are equal. But with increased size of the picture the quantity of light is spread over a larger surface. When the same quantity of light is distributed over a surface of two or four square inches, then the quantity of light on a square inch of the latter surface will only be half as great as on the former.

But the surface contents of two similar figures are proportioned as the squares of similar located lines—for instance, as the squares of their heights. But as the size of a figure in the picture is proportioned to the focal length of a lens, it follows that the surface contents of the same are as the squares of the foci, and as the amount of light is just the reverse of their surface contents, it follows further: *the amount of light of two lenses is proportioned as the inverse ratio of the squares of their foci.* Opening and focus, are, hence, the main elements for judging the amount of light which a lens has. The direct proportions of the former, the indirect proportions of the latter form the criterion.

When we wish to compare two lenses in this respect, we have to divide first the opening o, by the focus f, and find the square of the fraction.

The fraction $\frac{o}{f}$ is called the relative opening. Of the importance

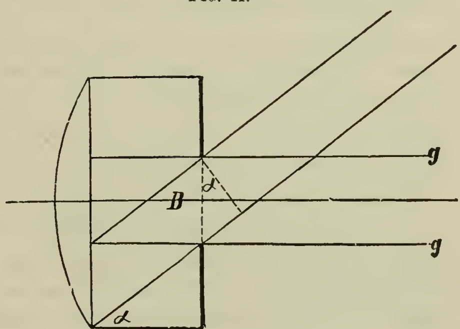
of the same we shall have something more to say in a future chapter on testing the objective.

This calculation holds good only for lenses with full opening. When, however, lenses are used that have stops, the size of the stop has to be substituted for the opening of the lens, and we can only compare front-stop with front-stop, and back-stop with back-stop.

The brightness of a picture, however, is not equal in all its parts. The eye alone tells us that the brightness of the image decreases from the centre towards the margin.

This circumstance is easily explained. Let us consider the simple case of a lens with a front stop. The diameter of the rays, g, g (Fig. 41), which pass through the lens parallel to its axis, is of the same size as the opening of the stop B. The diameter of the oblique bundle of rays is equal to the diameter of the stop multiplied with the cosinus of the angle of incidence, or equal to B cos. x, or, for instance, for an angle of $60° = \frac{1}{2} B$, and as the brightness is proportioned as the square of the opening, the brightness of centre and margin will be proportioned as 1 to 4.

FIG. 41.



With increased obliquity of the rays towards the lens the brightness of the margin of the picture will correspondingly decrease, and this is the reason why it becomes so prominent in wide-angled lenses.

To this must be added, that rays falling obliquely on a lens lose a considerable amount of light by reflection from the surface of the glass, and that this loss of light increases with the increase of obliqueness.

This causes, in short exposures, the apparent under-exposure of the margin. Sometimes this is of advantage, when it is desirable to concentrate the main light on a characteristic object located in the centre of the plate, as, for instance, on the head in portraiture. It becomes very annoying in pictures of buildings, landscapes, and drawings, however.

The above-mentioned reflections from the surface of the glass manifest themselves otherwise unpleasantly as they produce the so-called light spot (ghost) and secondary pictures.

When light falls on a lens, a part of it is reflected from the surface, another part enters the lens, passes through it, and on the back surface another reflection takes place. The reflected rays strike the front surface, are again thrown back, and are now by the back surface partly reflected, partly refracted, and thus a secondary picture is formed, which of course is very feeble and of little effect in short exposure, but which will make itself felt and seen with a long one. The focus of the secondary picture is dependent on the curve of the lens. Generally it is quite different from the principal focus of the lens, and the consequence is that the secondary picture does not appear sharp on the ground-glass when the lens is in focus, but only as a bright spot next to the bright object. With an increased curve of the surface of the lens the reflection will increase, and also the brightness of the secondary picture. By reducing the size of the stop, the sharpness of the secondary image increases (particularly in such lenses as the Globe lens), and when the front lens is struck by direct sunlight, or is turned to the bright blue sky.

When the focus of the secondary picture is infinite, then it will appear as an image of the stop, and will be distinctly noticeable as a bright spot in the centre of the picture. When, in such a case, we move the stop forward, the spot will become smaller and better defined, and the reverse takes place when we remove the stop backwards. The latter proceeding enables us sometimes to avoid or to reduce its evil effects.

We have still to explain what we mean by the expression, the field of view of a lens.

When a lens is screwed to a large camera and focussed on a distant object, we will notice on the ground-glass a bright circular disk. The diameter of the disk is independent of the size of the stop. When we compare lenses of unequal construction and equal focus, we will find that this similar image is of very different size. The angle, under which this picture is seen from the optical centre of the objective, is called the field of view of the lens.

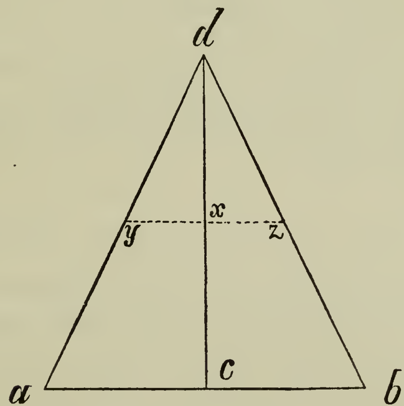
When *a b* (Fig. 42) is the diameter of the round picture, and *c d* equal to the focal length, then is the angle, *a*, *d*, *b*, the field of view.

Of the round picture only a portion will appear sharp—namely, the central part, and the sharpness will extend further towards the margin as the size of the stops decreases.

The practical size of the picture is, hence, for a given stop, always smaller than the field of view. This size, as well as the size of the field of view, is also determined by the angle, *d*, formed by lines drawn to two diametrically opposite points of sufficient distinctness.

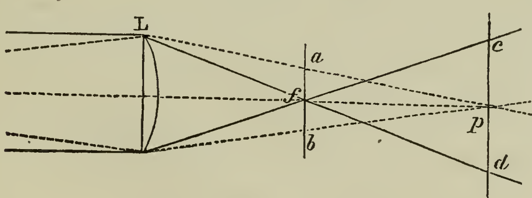
The term depth of focus denotes the capability of giving in the same plane an image of objects near and far. With objects which are further removed from the camera than fifty times the length of the focus of the lens, this is, *eo ipso*, the case; the images in this case are placed in the focus of the lens, the image of nearer objects is further removed

FIG. 42.



from the lens. If therefore objects which are very near and very far from the lens are to be represented at the same time, we cannot focus on them simultaneously with the full opening of the lens. If we

FIG. 43.



focus on the further one at f (Fig. 43), the nearer one, the focus of which is at p, will form a diffused circle of the diameter $a\ b$; if on the other hand we focus on the nearer one p, the further one will form a diffused circle ($c\ d$). On the size of this diffusion circle depends the want of sharpness; $a\ b$ is evidently smaller than $c\ d$.

It is therefore better to focus on the distant objects than on the nearer ones, except when the foreground is of the greatest importance.

The want of sharpness is here also proportioned as the square of the diameter of the diffusion circle. If we reduce the diameter of the lenses by employing diaphragms, the size of the diffusion circle will

also be reduced, and hence the want of sharpness decreases and increases with the square of the diameter of the lens; it increases also with the square of the focus. This is the reason why lenses of very long focus can only be furnished with relatively small openings. With small lenses of, say 6 inches focus, the opening may be increased to $\frac{1}{3}$ the focal length or 2 inches; if we would do the same with a large lens of, say 24 inches focus, we would have a lens of 8 inches diameter. This would increase the want of sharpness at p to sixteen times as much as with a small lens of 2 inches opening, and this want of sharpness would be very disagreeable to the eye. On account of their large opening, the portrait object-glasses have the least depth, while the pantoscopes have the most.

DESCRIPTION OF PHOTOGRAPHIC OBJECTIVES.

We have explained in the previous chapter the shortcomings of our lenses. We have demonstrated that these shortcomings, in the face of the exacting demands which are made upon a photographic lens, can only partially be overcome, and not entirely removed, and all our photographic lenses, even those of the very best construction, will leave something to be desired.

The qualities expected in a photographic lens are, 1. A great amount of light, to enable us to take, in the shortest space of time, the picture of a dark or a moving object. This can only be accomplished by a large opening and short focus. 2. Great sharpness even to the margin, a quality that can only be secured by the employment of small stops, and just the opposite condition to what is required in the first case. 3. A large and plain field of view. This requires very oblique rays of light, for which the spherical aberration and the curvature of the picture can only be corrected with great difficulty. 4. Freedom from distortion. 5. Absence of chemical focus. 6. Equal intensity of light over the whole field of view. 7. Depth, or equal sharpness for objects which are at unequal distances from the camera.

All these conditions can only be fulfilled with difficulty and not at the same time, and this is the reason why we have no universal lens answering all purposes. For this reason, also, we are compelled to employ different lenses for different work.

Most lenses conform, in a degree sufficient for practical purposes, to the condition mentioned under Class 5, but only partially to the other conditions.

The portrait objective fulfils condition No. 1, a large amount of light, but the others only imperfectly. The triplet objective and the

Steinheil aplanatic lens fulfil condition No. 4 (correct drawing); they excel the portrait lens in regard to condition No. 3, the field of view, and No. 7, but are inferior in regard to the amount of light. The pantoscope and the Zentmayer lens excel all others in field of view and depth (No. 7); are the equals of the previous ones in regard to No. 4 (correctness), but inferior in the amount of light. The Dallmeyer landscape lens answers the same conditions as the Steinheil lens, but is inferior to it in correctness of drawing and the amount of light. The Ross doublet fulfils the conditions similar to the latter, and is correct in drawing. Depth is only found in instruments with a small opening. The most perfect is the pantoscope, and the least so is the portrait lens. It is not to be wondered that we find so many different constructions which perform so well in one direction and do so little in another.

To describe all these constructions would be out of place in a work of this kind. We will only refer to those which we consider the most important and which we have tried practically. The manner of testing lenses we will explain further on.

1. THE SIMPLE ACHROMATIC OBJECTIVE, OR THE SO-CALLED LANDSCAPE LENS.

This simple objective is the oldest photographic lens in existence. Its forms are very different, but are always an achromatic combination, consisting of a pair of lenses cemented together, and with a front stop. Skilled photographers very often remove single lenses from a system, and use them with proper front stops for landscape work, where a little distortion is of trifling importance. The almost planoconvex front lens of a portrait combination is very often used for this purpose by reversing it and placing stops in front. For many purposes this is sufficient. There are many photographers who make reproductions with such a lens. The distortion becomes only perceptible when the field of view is taken too large. Within an angle of 15° it will hardly be noticed.

The lenses which were first introduced in the market under the name of landscape lenses had the following form:

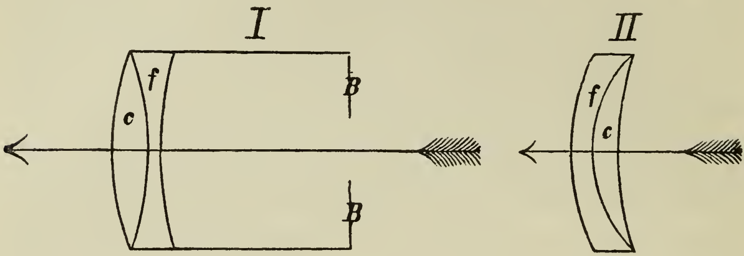
Fig. 44, *I: f* represents flint-glass; *c*, crown-glass. The stop, *B*, *B*, is generally one-fifth of the focal length distant from the lens.

We meet with this lens in many ateliers. Besides this form there are many others which, in regard to field of view, size of picture, and correctness of drawing, yield better results.

One of these is in the form of a meniscus, *II*, consisting of a con-

cavo-convex crown-glass and a convex-concavo flint-glass lens; both are cemented together with Canada balsam similar to the old lenses.

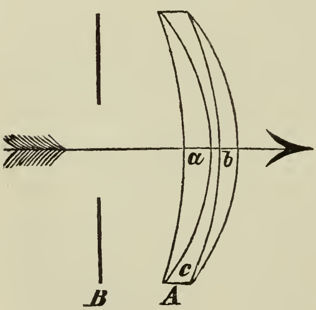
Fig. 44.



A third form, which gives still better results, is Dallmeyer's landscape lens, Fig. 45.

This combination consists of three lenses cemented together. The central one is made of flint-glass, and the two outer ones of two different kinds of crown-glass. The stop is placed at about one-tenth of the focal length from the lens. Instead of several stops, which can be changed according to the wish to increase the sharpness towards the margin of the field, the Dallmeyer lens is provided with a circular disk with different-sized holes; the disk is fastened to the tube.

Fig. 45.



The distortion of this lens is less than any of the other forms, also the curve of the picture; both are favorable to the size of the field of view, and give the further advantage that with rather large stops sufficiently sharp pictures can be obtained. The opening of the smallest stop is one-thirtieth of the focal length.

2. THE PORTRAIT OBJECTIVE.

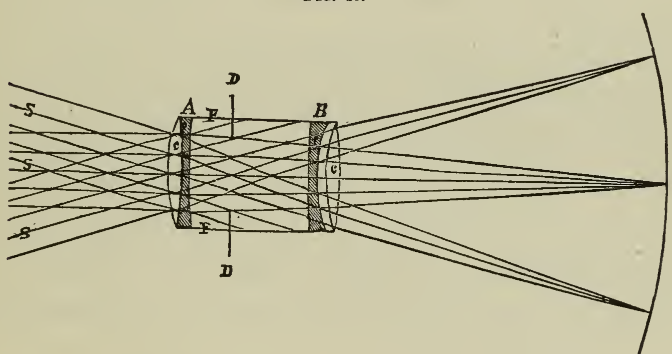
The Landscape objective was, in the earlier days of photography, almost exclusively employed. It suffices for landscapes, where the objects are at rest, where light is at one's disposal, and where a little distortion does not amount to much. For this class of work the landscape lens is employed to this day. The opening of such a lens, however, is small, under the most favorable circumstances one-

twentieth of the focal length, and the consequence is a proportionably small intensity of light, which becomes particularly annoying when we wish to take interiors, rooms which are only partially illuminated. A person in the glass-house had to sit in front of such a lens for several minutes, and this circumstance compelled the early photographers to place their models often in the open air, and even in direct sunlight. That in this way no artistically perfect pictures could be made is self-evident, and it became soon necessary for portrait photographers to have a lens that would work with a large opening, and hence have a large amount of light.

The invention of such a lens by Petzval, in Vienna, in the year 1841, was an event in photography, as by it portraiture became a possibility.

The invention of these lenses is no accident, but the consequence of a thorough theoretical calculation. Voigtlander, in Vienna, made

FIG. 46.



the first lens according to Petzval's directions, and Martin, in Vienna, took the first daguerreotype with short exposure.

This Portrait lens is a double objective with central stop and two unequal lenses.

The front lens, *A* (Fig. 46), consists of a biconvex crown, and an almost plano-convex flint-glass lens, which are cemented together with Canada balsam.

The back lens, *B*, consists of a plano-meniscus of flint, f', and a biconvex crown-glass lens, c', which are separated by a ring.

Between the two the central stop, *D*, is placed, which has to be smaller in proportion as we wish to push the sharpness of the picture to the margin. In this general form, all the portrait lenses coincide; only the new Dallmeyer portrait lens differs from it by the reversed

position of the back lens. Otherwise we find variations with different opticians in regard to focal length of the separate objectives, *A* and *B*, the distance and size of the same, the position of the stops, &c., which materially influence the qualities of the lens.

A comprehensive exhibit of these differences the table on page 71 is intended to furnish, which contains the result of the measurements which have been made in the celebrated optical establishment of Herr E. Busch, in Rathenow, with different portrait objectives of 36 lines diameter:

The effect of the two combined glasses is given in a great measure in the explanation in the previous chapter on the errors of lenses.

The front lens is almost entirely aplanatic, and would, if employed by itself in the original position, yield without stop a sharp but much-curved picture.

The front lens of a Voigtlander carte de visite lens of 68 millimetres diameter will give a picture at 330 millimetres focus. The addition of a second lens produces a shortening of the focus and an increase of light.

In the above-mentioned Voigtlander objective, by adding a back lens, the focus is reduced to 230 millimetres and the intensity of light, without taking the absorption of light by the glass into consideration, is increased in the reversed proportion of the square of the focus—*i. e.*, in the proportion of 529 : 1089, or, approximately, 1 : 2.

The more closely the lenses *A* and *B* are brought together the shorter the focus will become, and consequently we will have a corresponding increase in the intensity of light. But we observe that at the same time the curvature of the picture and the spherical aberration for oblique rays increase.

S′, *S″* (Fig. 46) are two oblique bundles of rays, parts of which pass completely through the front lens. Those parts, however, which, according to the explanation already made, would cause spherical aberration, are cut off by the mounting, *F*, *F*. The mounting acts as a stop, and by increasing its length a proportional quantity of oblique rays is excluded. It is easy to see that when the lenses *A* and *B* are far removed from one another the oblique rays, *S*, *S*, will be almost entirely cut off by the mounting; it follows then when the lenses are far apart the field of view will be reduced in size.

Consequently the distance of the two combinations is of much importance. In the commercial lenses which give much light, as, for instance, Mr. Ross's carte stereoscopic lenses, and also his rapid lenses for taking children's pictures, the two combinations are closely moved together, and the picture is very bright, but much curved; when we

bring it on the ground-glass without resorting to stops, only a small portion of the picture will appear absolutely sharp.

In the larger objectives, which, comparatively speaking, give less light, the distance between the two objectives is much greater, the focus is longer, but the picture is larger, darker, and less curved.

	OO.	*O.*	*I.*	*II.*	*III.*	*IV.*
Front lens. Equivalent focus in inches,	22.34375	20.125	17.9219	15.750	13.5469	11.3906
Back lens. Equivalent focus in inches,	35.46875	31.9219	28.375	24.822	21.2915	17.750
Double objective. Equivalent focus in inches,	15.250	13.729	12.0469	10.6875	9.2041	7.6875
Distance of the two objectives.						
Measured from the highest points of the two exterior convex surfaces, . . .	6.833	6.180	5.550	4.900	4.375	3.800
Measured from the mountings, ...	6.700	6.030	5.361	4.690	4.020	3.350
The diameter of the objective is proportioned to the equivalent focus nearly as	1 : 5	1 : 4½	1 : 4	1 : 3½	1 : 3	1 : 2½
The diameter of the objective (3 inches) divided by the focal length, . . .	0.1967	0.2185	0.2490	0.2807	0.3259	0.3902
The squares of the above quotients, ...	0.0387	0.0477	0.0620	0.0789	0.1062	0.1523
When the light of the system of lenses, *OO* is taken as *I*, then the other systems will be	1.000	1.232	1.602	2.039	2.744	3.935
Abbreviated, ...	1	$1\frac{1}{4}$	$1\frac{3}{5}$	2	$2\frac{3}{4}$	4
The intensity of light expressed in seconds might be expressed in the following manner, when a given picture, for instance, a carte de visite, should be made with all the lenses at once and all the stops being equal, the time would be.	40	32	25	20	$14\frac{6}{11}$	10

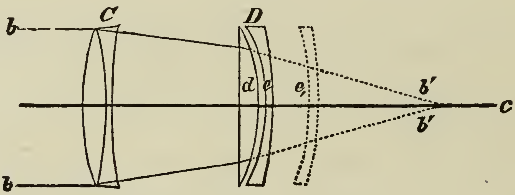
Of equal importance with the distance of the combination is the form. The separation of the crown and flint-glass lenses by a ring is peculiar.

The achromatic rays which have been refracted by the front lens strike the flint-glass lens, f', and suffer so much dispersion that the rays of the *axial* bundle, S, emerge almost parallel, the oblique rays, S', S'', diverge considerably; hence, it follows that for the axial rays, the change in the distance of the two lenses, f' and c', is of trifling importance when compared with the oblique rays.

When the ring is too small the margins of the picture will be deficient in sharpness, and the picture will be too much curved.

An objective which gives a picture of great curvature, and deficient in sharpness at the margin, can often be improved by changing the ring in the back lens. This of course requires great care and many experiments.

FIG. 47.



On the other hand, the distance between the two lenses has great influence on the achromatism; the blue rays, on leaving the flint-glass, diverge more than the yellow ones, or proceed apparently from a point nearer to the second lens, f, c', Fig. 46, than the latter. By increasing the distance of the two glasses, or what is the same, by increasing the size of the ring, we increase also the length of the chemical focus as compared with the optical one.

We meet with a peculiar construction of the back lens in Dallmeyer's new objectives.

The form is approximately the same as in the old objectives, but the position is reversed—*i. e.*, the flint-glass lens is back, and the crown-glass lens is in front; the distance of the two is variable, as the distance between flint and crown-glass lenses can be regulated by a screw movement.

With larger distance the marginal rays will fall on the lens nearer to its centre, where the dispersion is less; but with a shorter distance the rays will strike nearer the margin, where the dispersion is greater. The lens is so constructed that in the latter case the spherical aberration is almost entirely removed. When, by the screw movement, the lenses are removed from each other, a considerable spherical aberration is produced, and instead of one focus, a number of focal points, f', f'', f''', make their appearance. (See Fig. 36, p. 58.)

The ground-glass can be moved a little without interfering particularly with the sharpness of the picture, and securing, at the same time, depth of focus. Experience has taught us, however, that this supposition is not entirely admissible; at all events, the advantages gained by this screw movement are immaterial.

Besides the form, the size of the back lens exercises considerable influence. The lens is generally made wider than the front lens. This is the case in a striking manner in the conical objectives. By increasing the size of the back lens the effectual part of the bundle of rays, S', increases likewise, and which, with smaller lenses, is cut off by the mounting, F, F. The consequence is greater brightness of the margin of the picture, but also, as has been shown above, more spherical aberration of the oblique rays.

The portrait objective is nearly free from distortion.

As an example we give the result of an examination of Voigtlander's carte de visite objective:

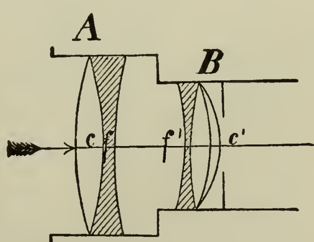
Diameter.	Focus.	Field of view.	Practical field of view with full opening.
68.5 millimetres,	230 millimetres,	43° 50′,	22° 10′.

3. THE ORTHOSCOPIC LENS.

For the copying of drawings, or for taking views of architectural objects, it is of advantage to have an instrument which will give as flat a field as possible. The Orthoscopic lens, calculated by Petzval, meets these requirements. Formerly this lens, besides those we have described above, was in general use; now, however, the Triplet has generally taken its place.

The Orthoscopic consists of a large concavo-convex front lens, A (Fig. 48), with cemented crown and flint-glasses, and a combination of lenses, B, the back lens, at the same time acting as a dispersing glass. This latter combination consists of a biconcave flint and a concavo-convex crown-glass lens.

FIG. 48.



The stops are generally arranged at the back of the lens.

A drawback to this form of lens is the distortion; the straight lines are generally curved inwards: this circumstance makes it less suitable for the copying of drawings and the taking of architectural objects than the Triplet.

4. THE TRIPLET LENS.

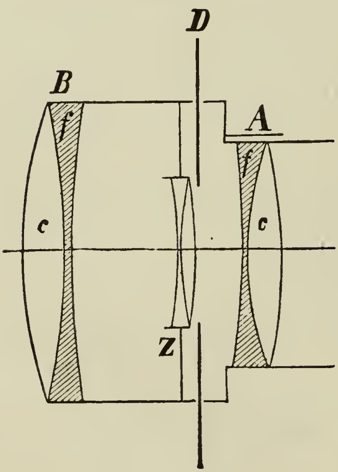
The Triplet objective owes its name to its construction. It consists of three systems of lenses, two achromatic collecting lenses and a smaller dispersing lens placed between them; the diameter can be more or less modified by central stops.

When two equal collecting lenses are combined to a doublet, with central stops, we will get a picture which has the advantage over the Orthoscope of being free from distortion and having greater intensity of light than a single lens of the same focal length, but at the same time the picture would be much curved. To remedy this defect Sutton introduced a concave lens between them. This lens acts as the dispersing one; it makes the rays diverge, and consequently the focus becomes longer.

The more converging oblique rays passing through the margin of the intermediate lens, which latter has greater dispersing power, will experience, consequently, a greater lengthening of the focus than the axial rays which pass through the centre of the lens.

The marked curvature of the picture is almost entirely obviated by this arrangement. The original triplet of Sutton was symmetrical. Dallmeyer deviates in many respects from Sutton's directions, and his triplets have a small front lens, *A* (Fig. 49), and a larger back lens, *B*.

FIG. 49.



The stops, *D*, are in front of the middle lens, *Z*.

The whole system gives, with the full opening, pictures which are sharp in the centre; as, however, the full opening is proportionally larger than in a portrait objective, the lens gives not quite as much light. To extend the sharpness to the margin, the use of stops is necessary.

The Triplet lens covers a larger and flatter field than most portrait lenses, and when correctly constructed it is free from distortion. The lens is frequently employed for the copying of drawings, architectural objects, and landscapes.

The deficiency in light makes them undesirable for portraiture. Dallmeyer states that by removing the middle lens the tube can be

used for portraiture. This would shorten the focus considerably and increase the intensity of light, but the field would appear very much curved, and the picture would not be equal to one taken with a common Portrait lens.

Lately Dallmeyer and also Busch have made experiments to increase the "light" of these lenses by increasing the size of the middle lens, and in this way an objective has been constructed which retains the large and flat field of view of the ordinary triplet, but which possesses a greater intensity of light, and thus approaches nearer to the Portrait lens. Busch's improved Triplet is known under the name of the Universal Triplet (so called because it is adapted to so many different purposes).

This Universal Triplet, on account of its large field, does good service in taking groups. A condition for success, however, is a good light.

To show a comparison of the old and new Triplet lenses, we give below the result of several experiments:

	Diameter of front lens.	Diameter of middle lens.	Focus.	Field of view.	Size of picture.	Relative size of stop.	Remarks.
Dallmeyer's Triplet, No. 1,	32 *m.*	18.5 *m.*	207	70° 40′	44° 30′	0.027	Slight distortion.
Busch's Universal Triplet.	64 *m.*	50.5 *m.*	390	72°	45°	Full opening.	Draws correctly.

The middle lens is in the older Triplets smaller than $\frac{1}{10}$ of the focal length, and in the Universal larger than $\frac{1}{8}$ of the focal length. The Universal cannot be used without the middle lens.

5. STEINHEIL'S APLANATIC LENS.

We possess, in the Triplet lens, an objective which combines, with correct drawing properties, a tolerably flat field and considerable intensity of light; but we cannot deny that these results are reached by a rather complicated process. The three lenses consist each of two glasses, each of which has two surfaces, so that in all we have twelve surfaces, to be ground and polished. The large number of surfaces reflects or absorbs a considerable quantity of light.

Steinheil, in Munich, attempted the construction of a lens which, being simpler in composition, should, in regard to its intensity of light, flatness of field, and correctness of drawing, equal the Triplet.

Thus originated the Aplanatic objective, which, in a remarkable manner, fulfils all these conditions.

Steinheil's Aplanatic consists of two flatly curved symmetrical lenses, *A*, *B* (Fig. 40). Each separate one is composed of two cemented meniscus lenses, consisting, however, of glasses of different refracting power. The construction is the result of careful calculations by Dr. Steinheil, which so far, however, have not been published.

The Aplanatic gives, with the full opening ($\frac{1}{7}$ of the focal length), a sharp picture of the size of $\frac{2}{3}$ of the focal length, and can, with good light, be used for portraiture, the same as the Universal Triplet; but it is slower than an ordinary portrait combination. What the lens is capable of doing will be best explained by a statement of the result of an examination by a committee of the Photographic Society of Berlin.

Diameter.	Focus.	Size of picture for portraits.	Land-scape	Field of view.	Practical size of picture with 0.026 stop.	Remarks.
19‴	10¼″	6¼″	10½″	—	—	According to the statement of price-list.
43 *m.*	296.6 *m.*	6″	—	65° 20′	43° 20′	According to the report of the commission.

Steinheil has lately constructed another wide-angled Aplanatic lens, which has a lesser light intensity than the old Aplanatic one, but a considerably larger field of view. We have found that the Aplanatic may be comfortably used with a field of view up to 60°, without impairing the sharpness. The Aplanatic is the best instrument for architectural objects, landscapes, and reproductions.

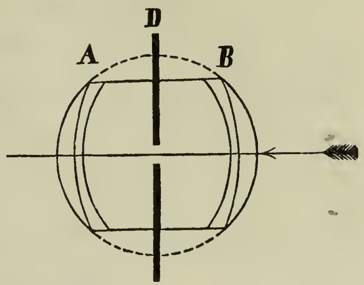
The latest novelty in the realm of wide-angled lenses is Steinheil's wide-angled Aplanatic lens, which excels all other wide-angled lenses in its light-intensity, although in this respect it is inferior to the old one. With full opening, it gives pictures which are sharp up to an angle of 80°.

6. THE GLOBE LENS AND THE PANTOSCOPE.

The lenses which we have described so far, have only a moderately large field, which, under very favorable circumstances, may extend to 60°. Such a field may be sufficient for most landscape and architectural purposes, but it is inadequate when the photographer has only a short distance between the lens and object at his disposal, a case of frequent occurrence in streets or interiors.

Harrison & Schnitzer, in New York, constructed a lens which is distinguished from former lenses by a very large field of view. The lens is a double objective, *A B* (Fig. 50), with symmetrical, strongly curved crown and flint glass lenses, the outer curves of which form a sphere; the lens is provided with stops, *D*.

Fig. 50.



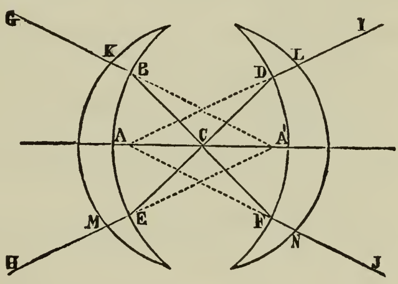
The stops are a necessary part of the objective. While the previously described lenses, Portrait lens, Triplet, and Aplanatic, will give sharp pictures without any stop, the Globe lens will show so much spherical aberration as to make the picture useless.

The consequence is that it is inferior in light to the previously described lenses, but excellent in other respects.

The small stop excludes a large quantity of light which strikes the open front lens, and only a small portion which falls nearly vertical on the lens is able to exercise any effect.

The annexed figure will illustrate the course of such a bundle of rays. The oblique bundles, *L I*, and *N J*, after being refracted by the front lens, pass through the centre of the objective and strike the points *B* and *E*; being here again refracted, they leave the lens parallel to their line of incidence.

Fig. 51.



The original Globe lens of Harrison showed only an angle of 75°.

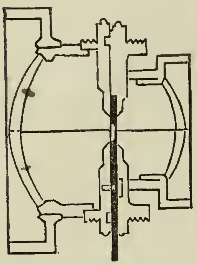
The Ross Doublet shows equal capabilities; its construction, however, is different from that of the Globe lens.

Busch, in Rathenow, has constructed an instrument similar to the Globe lens, which surpasses the latter lens in the size of the picture, and the picture shows the astonishing angle of 90° (field of view 105°). The picture which such a lens furnishes is twice as long as the focus of the lens.

The arrangement of the lens is similar to the Globe, but the external surfaces are not in the same sphere.

In a still more perfect manner Mr. Zentmayer has accomplished the same object by a combination of two strongly convex simple crown-glass lenses (Fig. 52). This Zentmayer lens is, particularly in America, where it originated, very generally employed where a short distance and large field of view are required.

Fig. 52.



The back lens is smaller than the front lens; the front lens can be used again as back lens of the next larger combination, an advantage which landscape photographers will fully appreciate.

Any variety of combinations and series of focal lengths might be constructed on the above principle; but the plan adopted is as follows: The most complete set consists of six lenses, the focal lengths of which are—

I, . . .	5.333 inches.	IV, . . .	18 inches.
II, . . .	8 "	V, . . .	27 "
III, . . .	12 "	VI, . . .	40.5 "

These may all be successively arranged in the same mounting, giving combinations with focal lengths and circular fields at 90° as follows:

Lenses I and II give a focal length of 3.55 inches, and field 7 inches diameter.

Lenses II and III give a focal length of 5.33 inches, and field $10\frac{1}{4}$ inches diameter.

Lenses III and IV give a focal length of 8 inches, and field 16 inches diameter.

Lenses IV and V give a focal length of 12 inches, and field 24 inches diameter.

Lenses V and VI give a focal length of 18 inches, and field 36 inches diameter.

Thus, with six lenses and one mounting, five different instruments may be successively adjusted in as many minutes, the mounting being so arranged as to fit in the camera either way. To pass from one focal length to the next longer in the series, it is only necessary to take out the smaller lens and put in its place the second size above. Thus, to change 8 inches into 12, lens No. III is replaced by No. V, and the mounting reversed. A little shutter, close to the central diaphragm, serves for "exposing" in place of a cap; and a diaphragm plate is arranged with three holes for each combination, a large one for focussing, a middle one for quick work, and a small one to

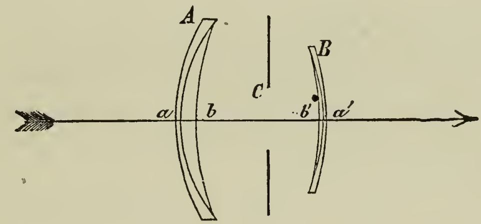
secure extraordinary sharpness; for it is one of the merits of this lens that a large stop may be used for focussing, and a small one thrown in for the exposure, with not only good, but the very best effect.

The decrease in the intensity of light towards the margin is a great disadvantage of the objectives with a very large field of view; the margins are frequently underexposed when the centre has received its full exposure; this becomes particularly apparent when the centre of the field contains bright objects, while the margins are occupied by darker ones.

In employing these instruments we have to observe, also, that the perspective is frequently exaggerated; the nearer objects appear too large, while those at a distance are too small.

As another in this line we must mention Dallmeyer's Rectilinear lens (Fig. 53). This lens consists of two achromatic meniscus lenses, *A* and *B*, with a stop between them. The position of the stop has been selected in such a manner that the bright spot in the centre (ghost) is avoided.

FIG. 53.



The Rapid Rectilinear lens, lately constructed by Dallmeyer, resembles the older Steinheil lens so much that it may be considered a copy of the latter, in which Dallmeyer has only made a few changes.

The latest invention of wide-angled lenses is Steinheil's Aplanatic lens, which surpasses all others in intensity of light, although it is, in this respect, inferior to the old Aplanatic lens. With full opening it yields a picture which is sharp up to 80°.

ON TESTING OBJECTIVES.

The general method amongst photographers is to take with a new objective a few trial plates. Such trials are very valuable; still the result is always one-sided, as it gives information only in regard to the size of the picture, the sharpness towards the margin, and the difference between visual and chemical focus, also in regard to distortion. The intensity of light is only superficially ascertained, and as for the

size of the picture, this in itself forms no criterion of the value of an objective.

We often hear the remark, that a portrait objective, which gives a figure twice as high as the diameter of the lens, must be a good one.

It is only necessary to examine the price-list of the opticians in order to find out that the size of the picture, with objectives of the same opening, varies considerably. So, for instance, the 3-inch lens by Busch (page 71) gives in

					Focus.
System I,	a picture of	7×9	inches,	12	inches.
" II,	"	$6 \times 7\frac{1}{2}$	"	$10\frac{7}{10}$	"
" III,	"	$4\frac{3}{4} \times 6\frac{1}{4}$	"	$9\frac{2}{10}$	"
" IV,	"	$4\frac{1}{4} \times 5\frac{1}{4}$	"	$7\frac{7}{10}$	"

If we would take the size of pictures as the test, the first should be the best. The last, however, which gives the smallest picture, is the most expensive.

In what consists the difference?

It is in the focus. With equal opening, the shorter the focus the greater will be the intensity of light of a lens. This shows how important it is to ascertain the focal length of an objective when we wish to judge of its quality. When the focal length is known, we can form an opinion of the intensity of light.

The intensities of light are, with equal opening, the reverse of the squares of the foci.

When we take, for instance, No. IV and No. I for comparison, the strength of light is proportioned as 12^2 to $7\frac{7}{10}^2$—*i. e.*, as 144 to $59\frac{29}{100}$, or almost as $2\frac{1}{2}$ to 1.

Hence System IV has $2\frac{1}{2}$ times the intensity of light of System I, and in this consists its superiority (see table, page 71, on the relation of intensity of light in the different systems, and the time of exposure necessary for each one). The focal lengths, however, are generally only approximately stated in the different price-lists. Many persons think that focal length is the distance between the ground-glass and the back lens, when the system stands in focus, or what is the same, projects a sharp picture on the ground-glass. This is correct only for the simple lens, but not for a compound combination.

For a combination of lenses, the focus, and the distance of the ground-glass from the back lens, are two entirely different things.

For an example, I will select the Steinheil lens. Its focus, according to the price-list, is $10\frac{1}{4}$ Parisian inches, or 0.276 metre. According-

ing to my measurements it was 0.296 metre. Similar discrepancies happen frequently, and as it happens very often that one does not know, by the focus, whether the distance of the back lens from the ground glass, or the actual equivalent focus, is meant, the importance to determine the length of focus becomes evident. Different methods have been recommended. I have tried them all, and consider the following the simplest and most reliable.

The objective which is to be tested, is placed on a long camera; a strip of black paper, of about four inches in length, with parallel sides, is cut out, and afterwards divided again lengthways. The one piece is pasted on a board, or on a piece of Bristol board; the other piece is pasted on the ground-glass; both are pasted in a vertical direction. The objective is now focussed on the black strip, and the camera is moved backward and forward until the image on the ground-glass corresponds exactly in size with the piece pasted on to it. To make the upper line of the image exactly correspond with the same line on the ground-glass, it will only be necessary to fasten with a string the board carrying the black paper to a nail in the wall, and to raise and lower it until the lines coincide; when the lower lines likewise coincide, the instrument is removed from the camera without changing the position of the latter, and the distance between object and ground-glass is exactly ascertained; by dividing this distance by four we get at the equivalent focus of the lens.

It is advisable to paste a piece of paper with small print on it upon the black strip, as it facilitates focussing.

When we know the focal length, we can draw a very nearly correct conclusion in regard to the intensity of light.

The opening is divided by the focal length, and the square of this figure is found. So is, for instance, the fraction for—

Voigtlander C. de Visite.	Auzoux 3 inch.	Busch's Portrait Triplet.	Steinheil.
$\frac{68.5}{230.4}$	$\frac{76}{350.5}$	$\frac{64}{390}$	$\frac{43.5}{303.06}$

Or expressed in simple figures—

$\frac{1}{3\frac{4}{11}}$	$\frac{1}{4\frac{4}{7}}$	$\frac{1}{6}$	$\frac{1}{7}$

The squares of these figures are—

$\frac{1}{11.3}$	$\frac{1}{21}$	$\frac{1}{36}$	$\frac{1}{49}$

Theoretically, the intensity of light of the different objectives will bear the same relation. Practically, there are many exceptions to

this rule; the more or less fine polish, the color and form of the glass, play an important part, but the above calculation will give an approximation.

As important as the determination of the focal length is for finding the intensity of light, so also it serves to determine the extent of the field of view. The lens is screwed to a *very large camera* in order that the circle of light may be completely visible on the ground-glass.

The diameter of the circle should be exactly measured, and transferred to a piece of paper (see *a*, *b*, Fig. 42). In the centre a vertical line should be erected, *d*, *c*, its length being the same as the focal length of the lens, and we next construct the triangle, *a*, *d*, *b*. The *angle* at *d* is the *field of view of the lens.* This angle is easily measured with a protractor.

The possessors of trigonometrical tables do not require this construction, but can determine the angle from the radius of the circle of light and the focus. The tangent of half the angle of the field of view is equal to the radius of the circle of light divided by the focus.

When we take a picture in which the whole circle of light is visible, we will find that only the central part is sharp and fit for use; but by substituting smaller stops the sharpness will extend further and further towards the margins. How far the sharpness is useful for practical purposes depends entirely on individual opinion. Some photographers are in this respect extremely pedantic, while others are satisfied with moderate results.

The nature of the object also (whether portrait, landscape, or reproductions) plays an important part. When we desire to determine how large the actual practically useful field of a lens is, we have to find out the extreme points where the sharpness is still sufficient, and then apply a rule and ascertain the diameter of the practically useful surface.

When we execute the same construction as above, we will find the practical angle of the field of the picture.

The introduction of stops has of course a considerable influence in extending the field; and in comparing the performance of two objectives, the sizes of the stops must not be overlooked. It is, however, incorrect to measure the size of the stop only. In order to get a correct guide, the size of the stop should be divided by the focal length of the respective objectives.

The size of the picture is only to be considered when the instrument is nearly in focus with the ground-glass. It is quite different when the picture is removed from the focus. A carte de visite lens, for instance, will give in its focus a picture of about three inches; but an

object three inches long, placed in the focus of the lens, would if projected on a screen, or on the ground-glass, be five feet long. The size of the picture is, hence, only relative, when expressed in definite terms, while the angle of the picture remains, under all circumstances, the same.

To test for focal differences, a large book or a newspaper which has been pasted upon a piece of pasteboard should be placed obliquely in front of the lens, the lens should be focussed sharply upon the middle line, and the camera should be placed at such a distance that the letters are about the natural size.

We now take a picture; if the line upon which we have focussed is sharp, then the lens has no focal difference; if another line is sharp the lens has either focal difference, or the position of the plate in the plate-holder and the ground-glass in the focussing glass do not coincide exactly. To find out if the plate-holder is at fault, we discard the ground-glass frame and focus with the plate-holder by placing in it a piece of ground-glass of suitable size. If again another line than the one on which we have focussed appears sharp, we may be sure that the lens has a focal difference.

To take with such a lens a sharp picture requires a correction in the mode of focussing. Suppose that instead of the first line upon which we have focussed the third line should come out sharp, then it follows that in order to obtain a sharp picture of the third line we must focus upon line one.

If we mark on the objective the place when the lens is focussed for line one, and also when focussed upon line three, and the lens has to be moved forward for the space of this difference after having sharply focussed for an object in order to obtain a sharp picture, it must be remembered that this difference varies with the distance of the camera from the objective.

If, for instance, we wish to fix the focus difference for portraits, the test object should be placed at the distance where the sitter is to be placed.

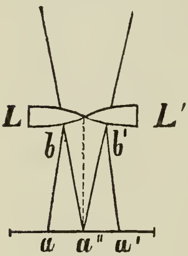
THE STEREOSCOPE.

When we look with both eyes at a near object, the view which each eye obtains of the object will be different. The left eye will see more of the left side, and the right eye will see more of the right side of a body. Both views combined produce the effect of solidity. In 1838, Wheatstone tried to produce a similar effect by looking at two pictures, one of which represented the object as it would appear to the left eye, the other gave the right-eyed view; and his experiment was

successful. He saw the plain figures solid. The figures employed by him were drawn by hand, and consisted of lines and circles. The construction of pictures representing complicated objects, as landscapes and persons, offered greater difficulties; and such pictures became only possible by means of photography. At the same time a handy instrument for viewing these pictures was invented by Brewster, which he called the stereoscope, an instrument which, at the present day, is found in every drawing-room. Stereoscopic pictures and cartes de visite rival each other, and both of these articles have become an incentive for the photographer to furnish the most perfect productions for the lowest price.

Brewster's stereoscope consists of two prismatic pieces of glass, $L\ L'$ (Fig. 54), which, when attached to each other by their bases, would form a biconvex lens. Both the prismatic glasses are mounted in a piece of wood in such a manner that the points are opposite to each other, and that both correspond to the position of the eyes. When we now look at a stereoscopic picture, through these glasses, by bringing them close to the eye, and placing the picture at a distance where the objects appear plainest, the two pictures will appear as one, and give a perfectly plastic impression.

Fig. 54.



The coalescence is explained by the fact that the lenses act like prisms—*i. e.*, divert the lenses of the eye in the direction of the refracting edges.

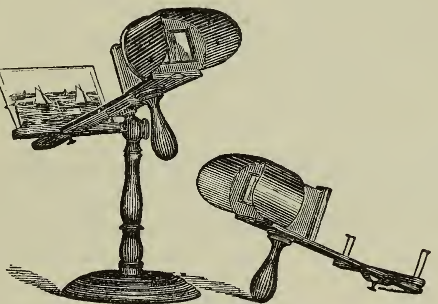
Suppose that a and a' are two corresponding points in the stereoscopic picture, and L and L' the lenses, then the rays $a\ b$ and $a\ b'$ will be so diverted that they will appear as if they proceeded from a single point, a''.

In order that this appearance may take place in a normal manner, it is necessary that the pictures should be mounted at a proper distance from each other. A trial will soon establish the necessary distance. As the stereoscopic glasses are lenses, they act at the same time as magnifiers; they *enlarge the picture*. Lenses have the effect of placing the objects at the distance of most distinct vision, and as this distance is different in different individuals, it follows that the distance of the glasses from the picture depends on the individuality of the observer.

For this purpose stereoscopes have been made where the glasses can be moved, or where the picture can be brought nearer to or removed further from the glasses. The latter is the case with the American

Stereoscope (Fig. 55). This is an open instrument, in which the picture receives light from every direction, and is consequently much better lighted than is the old box stereoscope.

Fig. 55



Generally the picture is near the focus of the lens with which we view it; it is essential also that the focal length of the lenses with which we view a stereoscopic picture, should be of nearly the same length as those with which the picture was taken. When this is not the case a wrong stereoscopic effect will be produced, and this causes the exaggerated perspective in pictures which have been taken with lenses of very short focus, and are viewed with lenses of only slight magnifying power.

Stereoscopic pictures are either taken with a camera with two objectives, the distance between them being about the same as the distance between the eyes ($2\frac{1}{2}$ inches), or they are taken with a single objective by placing the camera first in the position of the right eye, and then the left.

For very distant objects, the distance has to be increased in order to recover the plastic effect; in landscapes this amounts sometimes to as much as several feet. For near objects excessive distance exaggerates the prominent points, and in case of a person, the nose or hands seem to project several feet from the body.

THE PANORAMIC APPARATUS.

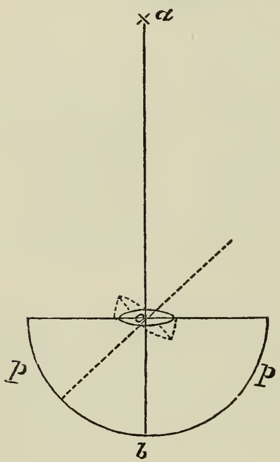
The generality of photographic apparatus has only a very limited field of view, and does not admit of taking a view of considerable lateral extension, such as we frequently meet with at the seashore or in the mountains; for instance, the panorama of the Rigi, or the Faulhorn. Martens, an engraver in Paris, conceived the idea of

taking such pictures with a rotating camera, which would successively take in the whole horizon.

He constructed, in 1847, a camera with a cylindrical daguerreotype plate; the plate remained stationary while the camera with the objective revolved; the light acted on the plate through a small slit. It is easily demonstrated that, in spite of the revolving motion of the camera, the picture of the same object must always be projected on the plate in the same spot. The *image* of a point lies always on the straight line which is drawn from the point through the centre of the lens.

When *a* (Fig. 56) is such a point, and *o* the centre of the objective, *P*, *P*, the cylindrical plate, then the image of the point will be on a line, *a b*, drawn through the plate from *o*. When now the objective is moved around its centre (as is indicated in the figure by the dotted lines), then the image of *a*, according to the principle stated above, will still remain on the same line, *a b* (because *a* and *o* do not change their positions), and will fall again on the point *b* of the plate, and notwithstanding that the objective moves constantly, all the points of the object will be sharply defined in the picture.

Fig. 56.



The above holds good only, of course, when the rays do not form too large an angle with the axis. To prevent this, a diaphragm with a narrow slit is placed opposite the lens, the opening of which is parallel to the axis of rotation, and which moves simultaneously with the objective.

The fault of Martens's apparatus is the cylindrical plate, the preparation of which in the ordinary collodion process offers great difficulties.

Brandon introduced in its place a plane plate, which, during the rotation, rolls itself, so to speak, off the cylindrical surface of the image, following the motions of the objective.

The mechanism, to execute the motion in an exact manner, differs widely, and the opinions vary considerably as to which manner of construction is the most practical.

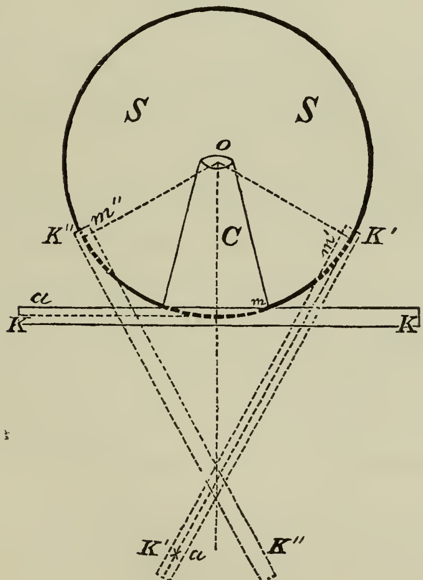
Generally the camera, *C*, Fig. 57, with the objective, *o*, is placed on a horizontal metallic plate, *S*, *S*; the camera rests on small wheels

and revolves around an axis which passes through the optical centre of the objective.

The wheels are moved by clock-work. The plate-holder runs in a movable groove, as in a carte de visite camera. A cord wound around the disk, *S*, *S*, the ends of which run off in the direction of the tangent, and which are fastened to the ends of the plate-holder at *a*, causes the latter to move, and to occupy successively the positions which, in the annexed figure, are illustrated in three phases,—beginning at *K'*, *K'*, centre at *K*, *K*, end of motion at *K''*, *K''*.

The pictures obtained with this apparatus are evidently projections on a cylinder unrolling itself. The vertical lines are reproduced vertical, but the horizontal ones, unless they coincide with the horizon of the apparatus, are represented as curves.

Fig. 57.



When we take a house front or a street with this apparatus, the top lines will appear as an upward curved line, while the base lines will be curved in the opposite direction, which effect becomes more unpleasant when the line is very long and far removed from the horizon.

For architectural views this apparatus can only be used to a very limited extent, and a wide-angled lens is decidedly preferable.

CHAPTER IV.

THE NEGATIVE PROCESS.

SECTION I.

PREPARATION OF THE CHEMICALS.

Rules of Precaution.

A PIECE of paper and a lead-pencil are sufficient for a draughtsman to reproduce or to make the picture of any object. He spreads the paper, he points his pencil, and all his preparations are made. The work can commence.

It is quite different in photography. Even to make the smallest and least important picture requires a quantity of apparatus—camera, tripod, lenses, plate-holder, dishes, bottles, basins, and a number of solutions—silver-bath, developer, fixing-bath, &c., and the preparations, which, for the draughtsman, are made in a few seconds, may, for the photographer, require hours. He has, however, the other advantage, that the taking of the picture will be accomplished in a few minutes, while a draughtsman would have to work hours or days, and then he would have but one picture, while the photographer will have a plate from which he can produce hundreds or even thousands of prints.

The preparation is therefore the main thing in photography, and it must be made with the greatest accuracy and cleanliness on the one side, and with presence of mind, knowledge, and taste on the other, if we expect to realize a satisfactory result.

What advantage is there in the best collodion, and the cleanest and most carefully prepared plate, if the person represented is ill posed or badly illuminated; what advantage, on the other hand, is the most tasty arrangement when the silver-bath refuses to work properly? And what shall I do with a plate prepared with the best material, clean and perfect in every particular, and the object represented be ever so beautiful, if the lens does not work properly, or the

focussing has been carelessly performed, and the picture looks distorted and does not possess sufficient sharpness?

Each separate branch of the preparatory work, and there are many of them, must be carried out with the greatest care. Nothing must be forgotten, and nothing must be considered as being of little moment. And whoever does not go to work, in this respect, with the greatest and most conscientious care, will never become a great photographer, but always remain an incompetent.

I would advise beginners in particular not to attempt to take a picture until they feel fully convinced that all the apparatus and chemicals, from first to last, are in a normal state and ready for use. How often has it happened to me, with my scholars, that a plate has been coated with collodion and has become dry because the dipper was not handy. How often has an exposed plate been spoiled because the developer was not handy or had not been made at all, not to mention numberless other " accidents."

The preparations are, according to the nature of the work, very different. They are different for the negative and different for the positive process, different for the carbon print, and different for the silver print, or the enamel process. We will first consider the process on which all the others depend,—*i. e.*, the negative process.

The chemicals necessary for the different photographic processes are generally mixed beforehand ready for use. The especially important mixtures are the *collodion*, the *silver bath*, the *developer*, the *intensifier*, and the *fixing solution*. These fluids are absolutely necessary before one can commence to work, and they must be in such a condition that we can rely on their good qualities. In their preparation, preservation, and treatment the greatest care is necessary, and particularly the greatest cleanliness is to be observed in the preparation of the collodion and nitrate bath. When a mistake has been made it will manifest itself in every plate, and success becomes impossible. The utmost care is therefore the more necessary, as even the smallest homœopathic quantities, which can hardly be traced by analytical tests, when present in the collodion or in the bath, are apt to make all photographic success an illusion.

The author knows hundreds of photographers, who, either from carelessness or ignorance, neglected to clean a funnel, and, without suspecting it, ruined their collodion or nitrate bath, and who afterwards had ten times as much trouble to restore their chemicals to working order, as it would have taken to give to the funnel the most thorough cleaning.

1. PREPARATION OF THE COLLODION.

The great care which has been recommended above refers particularly to the preparation of the collodion. A silver bath is easily mixed, and it can be used at once if the old bath should refuse to work. A new collodion, however, can, under most favorable circumstances, only be used successfully a day after it has been mixed.

The photographic collodion is a solution of pyroxylin in a mixture of alcohol and ether, with which certain salts are mixed, the so-called iodizing salts; it serves to produce the sensitive film.

When a glass plate is coated with this collodion, a film containing a combination of collodion and this iodizing salt will remain on the glass; when this plate is now dipped into the nitrate bath, the salts of iodine and bromine will decompose, and iodide and bromide of silver (which are very sensitive to light) will take their place on the film, while a combination of nitric acid with a base will remain in the bath.

We will first consider the properties of pyroxylin (gun-cotton). How it is made I will not explain here, for I hardly think that a photographer will attempt to make it himself, as there are plenty of sources from which to get a good and reliable article.

PYROXYLIN.

The pyroxylin is obtained from cellulose or vegetable fibre, which forms the main substance of wood, paper, cotton, and all vegetation. It was discovered in 1846 by Schönbein, and attracted at that time, under the name of gun-cotton, great attention as a substitute for gunpowder.

Pyroxylin is a substance which is obtained by placing cotton or linen paper into a mixture of concentrated nitric and sulphuric acids, and afterwards by careful washing in water, and drying. A peculiar process, the process of substitution takes place, and C_{12} H_{10} O_{10} (or cellulose) loses three or less atoms of hydrogen (H), which are replaced by nitrous acid (NO_4). The so changed cotton has not altered its form. To the touch, it is a little more coarse, but its chemical properties are materially different. Its weight has been increased by a quarter to one-half. It explodes by being lighted; it is soluble in acetic ether, also in alcohol-ether, and on evaporation of the solvent, it separates as a vitreous film. On this property the employment of pyroxylin as the picture-carrier depends. Potassium dissolves it by decomposing

it and NO_5 and NO_3. Salts are formed, and also an organic compound which reduces the salts of silver, and is used for silvering.

When pyroxylin is treated with reducing agents, for instance, acetic acid and iron, it is changed to ordinary cotton. Of all the properties of pyroxylin, the photographic one interests us here the most, *i. e.*, the solubility in alcohol-ether, and the quality to yield, on evaporation, a perfectly homogeneous, vitreous, and transparent film, which possesses sufficient firmness to withstand the action of a spray of water, and which is as indifferent as possible to the various photographic chemicals.

Formerly only one kind of pyroxylin or nitro-cellulose was recognized, but it soon was found that the solubility in alcohol-ether was variable; that some pyroxylin is not soluble, and that on the other hand the solutions of the same showed different qualities according to the mode of preparation, and fulfilled the above-mentioned conditions of their photographic usefulness perfectly. This gave rise to a close study of these modifications. Hadow made a very careful investigation, and, based on these experiments, he describes the following four kinds of pyroxylin:

$$1.\ C_{36} \left.\begin{matrix} H_{21} \\ X_9 \end{matrix}\right\} O_{30} = C_{12} \begin{matrix} H_7 \\ X_3 \end{matrix} O_{10}$$

$$2.\ C_{36} \left.\begin{matrix} H_{22} \\ X_8 \end{matrix}\right\} O_{30}$$

$$3.\ C_{36} \left.\begin{matrix} H_{23} \\ X_7 \end{matrix}\right\} O_{30}$$

$$4.\ C_{36} \left.\begin{matrix} H_{24} \\ X_6 \end{matrix}\right\} O_{30}$$

Hadow triplicates the formula of cellulose—X is a simple sign for NO_4.

The combinations are obtained by immersion in acid mixtures of different intensities.

No. 1, by immersion in the strongest, the other No. in weaker ones. In regard to their explosiveness and solubility, they show very great differences.

No. 1 is the explosive gun-cotton. This is insoluble in alcohol and ether, but soluble in acetic ether. It separates on evaporation as a white powder. It is useless for photographic purposes, but excellent for blasting.

Nos. 2 and 3 are soluble in alcohol-ether, even in absolute alcohol, and No. 3 in glacial acetic acid. On evaporating an alcohol-ether solution a glassy-looking film remains well adapted to photographic purposes.

No. 4 is soluble in the same solvents, but leaves on evaporation an opaque film, and is useless for photographic purposes.

It follows from the above that only Nos. 2 and 3 can be used for photographic purposes. They are obtained by immersion in nitric acid of a certain strength. If the acids are stronger we obtain No. 1, or explosive gun-cotton; if weaker, the result will be No. 4.

The commercial pyroxylins are but seldom simple compounds, but generally mixtures of the above-described varieties.

But as ordinary cellulose, although unchanged in composition, shows great physical differences (compare, for instance, cotton, linen, velvet, wood or paper), so also are the physical properties of the pyroxylin and the collodion prepared from it very variable.

Pyroxylin is generally made from cotton or silk tissue-paper; when made from the latter it is called papyroxylin. When carefully made the one is as good as the other.

For the wet process a cotton should be selected which has been made at not too high a temperature. Such a cotton is long-fibred, yields a thick collodion, and contains but little foreign substance. Generally, however, gum-like substances are found in it which cannot be removed by washing, and which gradually will change the nitrate bath; they are called in photography organic matter. A recently introduced cotton which is sold under the name Celloidin, is free from these impurities, and therefore recommends itself for photographic purposes.

Gun-cottons prepared at a very high temperature have a shorter staple, are dusty, and yield a thin solution; these are better suited for dry plates. It is advisable to test commoner gun-cotton for acidity. A small sample is moistened with distilled water, and pressed upon a piece of blue litmus-paper; if the latter turn red, the cotton contains acid; the acid is removed by washing with distilled water, to which $\frac{1}{10}$ of ammonia has been added. The cotton is next dried; this is done in a porcelain or metallic dish, over boiling water. It has lately been tried to purify gun-cotton by dissolving it in alcohol and ether, and pouring the solution in a large quantity of water. The pure dissolved pyroxylin precipitates, is washed and dried; the foreign substances remain in the water. We prefer the celloidin, which is also pure and cheaper.

Pyroxylin is soluble in different substances, as, for instance, in acetic ether, in acetous or nitrobenzole, &c.

The best photographic solvent is a mixture of alcohol and ether, from which the collodion on evaporation separates as a transparent glutinous film. The properties of this film vary not only with the

kind of pyroxylin employed, but depend also on the qualities of the solvents that have been used. *The more rapidly they evaporate the more firm will be the film, and with slow evaporation the film will be correspondingly soft.*

With an excess of ether the film becomes strong and cohesive, contracts easily, and does not adhere firmly to the glass; it can often be removed entirely from the plate without tearing it.

With an excess of alcohol the film is tender and tears easily. This is the case to a still greater extent when the collodion contains water.

When to a good collodion water is added, a precipitate will be formed, which will redissolve on shaking. The collodion is now slimy; the film seems transparent, netted, and very tender. These faults will show themselves when we employ an alcohol containing much water; to obviate it, we have to increase the proportion of alcohol. Here, however, another drawback manifests itself very soon: the ether evaporates and the remaining collodion yields as tender films as before; such a collodion can be improved again by adding ether to it.

How much alcohol and ether are necessary depends on the raw material. For cotton which shows a tendency to give a slimy and rotten film, much ether and $\frac{1}{8}$ — $\frac{1}{12}$ alcohol should be taken. For cotton which has been prepared at a high temperature, and with a mixture containing much sulphuric acid, and which, in consequence, gives a firm, structureless, rapidly drying, and easily contracting film—*i. e.*, a parchment-like collodion—more alcohol than ether should be used.

The strength of the alcohol is very important. For slimy collodion the alcohol should be absolute, while for a parchment-like sample the alcohol may contain water. Hardwich recommends for the latter, when the alcohol is absolute, 2 parts alcohol to 1 ether.

For hot seasons and climates a collodion with much alcohol is to be recommended, as it will otherwise dry too rapidly. According to Hardwich, the alcohol not only acts physically, but also *photographically.* It *increases* the *sensitiveness* and the *intensity.* The former is only up to a certain limit increased by the addition of alcohol: when this limit is exceeded a diminution takes place; but it is different with the intensity, which, particularly in warm weather, with a collodion containing much ether, is very feeble. The porous character of the film certainly exercises an influence here.

The amount of cotton exercises a great influence on the sensitiveness. *The more cotton a collodion contains the greater will be its sensitiveness.* This holds good at least to a certain extent. Of different samples of cotton, the one which yields the thickest collodion is gener-

ally the most sensitive, provided that the quantities of alcohol and ether are equal. When a cotton turns out a very limpid collodion, it is advisable to make it a little more concentrated. Plain collodion should be made first; this should be left to settle, and to the clear solution the iodizing salts should be added.

In Germany we generally take for plain collodion one-half alcohol and one-half ether. Both must be neutral, pure, and free from essential oils. The cotton is weighed out, say, for instance, 20 grammes; to this is added 500 grammes of alcohol of at least 95 per cent. The percentage of cotton cannot be increased at pleasure, for with 3 per cent. of cotton, the collodion becomes already so thick that plates are coated with it with difficulty; and when the cotton is perfectly saturated with alcohol, 500 grammes of ether of a specific gravity of 0.725 is added; the bottle is now well shaken, until all the cotton has dissolved; it is now placed for at least a week in a cool dark place for settlement; when the collodion has become perfectly clear, it is decanted off. I generally keep on hand plain collodion containing two and four per cent. of gun-cotton. The former is for ordinary collodion; the latter is added to give any desired consistency. When all has dissolved, this mixture is tested with litmus-paper, to see if it has an acid reaction; should the latter be the case, it has to be neutralized with a pinch of carbonate of soda.

Collodion must be kept in the dark in well-corked bottles. According to its preparation it will keep for a shorter or longer space of time. Its keeping qualities depend in a great measure on the nature of the cotton.

Half-decomposed pyroxylin, which has been made from old linen at a high temperature, will not keep long even if it should work well at first. To test plain collodion for its keeping qualities, it should be well shaken with dry carbonate of potash; if it is good, it must remain colorless for the first two hours; if it turns rapidly brown, it will not keep long.

The ether also has something to do with its permanence. It is often ozonized, and liberates iodine from the metals of iodine that have been added.

Such collodion will work very intense at first, but it will not keep. In oxidizing, aldehyde and acetic acid will be produced, which also act injuriously.

IODIZING SALTS.

The plain collodion, which is the bearer of the picture, may be mixed at once with the sensitive salts of silver, which in this case re-

main suspended in the collodion. This, however, is not generally done, but the iodide and bromide of silver are formed in the film by adding the iodine and bromine metals to plain collodion, and by dipping the plate coated with this mixture into a solution of nitrate of silver, by double decomposition iodide and bromide of silver are precipitated in the film itself. The addition of the metals of iodine and bromine to plain collodion is called iodizing, and the salts which are employed are called the iodizing salts, and the collodion, after being mixed with these substances, is called iodized collodion, or often simply salted collodion (the former expression is, in so far, incorrect, as not only iodine, but also bromine metals, are added to the collodion).*

We will now consider a little more closely the properties of the iodizing salts and the salted collodion. It is evident that of the numerous iodine and bromine metals only those can be used for salting collodion which are soluble in alcohol and ether.

The following are employed:

Iodide of potassium (KI), atomic weight = 166.12, is a salt free from water, which crystallizes in cubes; it melts easy at glowing heat; when the temperature becomes higher it evaporates; it is easily soluble in water; at 12° C., 1 part of iodide of potassium is dissolved in 0.735 water. The solution of iodide of potassium dissolves iodine in considerable quantities. It does not dissolve readily in alcohol; 1 part KI requires from 40 to 60 parts of strong alcohol, according to Hardwich 180 parts of absolute alcohol. In its crystallized state, it does not change in the light; dissolved in HO, it soon turns yellow in the light, and iodine is liberated. *Its reaction is alkaline.* Dissolved in 5 to 10 HO, no reaction is perceptible; but when a piece is moistened with HO, and placed on violet litmus-paper, the latter will after awhile assume a wine color (that this change of color does not take place at once is probably owing to a decomposition). Hardwich states that the pure salt changes color in the light; when this is not the case, it is owing to the presence of a free alkali.

Bromide of potassium, atomic weight 119.12, crystallizes, free from water, in cubes, the same as iodide of potassium; is permanent in the air; melts at a red heat; dissolves very readily in water, but very slowly in alcohol, so much so that it will precipitate under double decomposition, when a saturated alcoholic solution of iodide of potassium is replaced by the solution of one of the bromine metals, for

* The reason why the salts of bromine are also added to the collodion will be explained further on.

instance, bromide of cadmium. According to Hardwich, an ounce of collodion, containing $4\frac{1}{2}$ ether and $3\frac{1}{2}$ alcohol, will only dissolve $\frac{1}{4}$ grain of bromide of potasssium. KBr dissolved in 10 parts of water has a neutral reaction; but when pieces of it are moistened with water, and laid on pieces of litmus-paper, its reaction is decidedly alkaline.

The difficulty with which iodide and bromide of potassium dissolve in water renders their employment in iodizing collodion rather difficult; it happens not unfrequently that they will crystallize out of the solution, particularly at a low temperature, and form precipitates, which in the photographic practice give rise to spots. I employ them only exceptionally.

Iodide of sodium ($NaI + 4HO$), atomic weight = 186, crystallizes with 4 atoms of water in small spear-shaped crystals; decomposes in the air. It dissolves very easily in water, and quite freely in alcohol; 100 parts of alcohol of 95 per cent. will dissolve, at 15° C., 8.33 parts of iodide of sodium. On account of its solubility, it is preferable to iodide of potassium. In its other qualities it is very similar to iodide of potassium. A great deal of the NaI of commerce is almost free from water.

Bromide of sodium ($NaBr + 4HO$), atomic weight = 139, crystallizes containing a certain amount of water; it is not influenced by exposure to the air; dissolves readily in water, slightly in alcohol, but better than bromide of potassium. The solubility of the pure salt is not known. In the presence of iodide of cadmium 100 parts of alcohol at 95° will dissolve (according to the amount of cadmium) 0.8 to 1.3 iodide of sodium.

Unfortunately iodide of sodium, as well as bromide of sodium, when purchased commercially, are very seldom pure, and occasion, when employed photographically, many inconveniences.

Iodide of ammonium (NH_4I), atomic weight = 145, is a very unstable salt, which generally is half-decomposed when purchased; it readily parts with iodine and becomes yellow. When fresh its reaction is alkaline; it dissolves in alcohol much more readily than KI and NaI, and must be kept in a dark place. Its impurities are very often $Am\,O\,C\,O_2$ and $S\,O_3$. The yellow mass is made white again by shaking with ether, or by adding a drop of sulphate of ammonia; its solubility in alcohol has caused its general employment in photography.

Bromide of ammonium ($N\,H_4Br$), atomic weight = 98; it is made by the direct action of ammoniacal gas on bromine; nitrogen escapes and $N\,H_4Br$ remains. It is a more constant salt than $N\,H_4I$, and

dissolves more readily in alcohol than KI and NaI. 100 parts of alcohol at 95° will dissolve 3 parts of NH_4Br.

Iodide of lithium (LiI + 6HO) contains, according to Rammelsberg, 6 equivalents of water; is deliquescent in the air, and turns yellow; dissolves readily in water and alcohol. It is only rarely employed for iodizing.

Bromide of lithium ($LiBr^2$); its qualities are not very well known. It dissolves, like LiI, readily in alcohol, and is only exceptionally employed.

Iodide of calcium (CaI) and *Bromide of calcium* (CaBr) form salts easily soluble in water, which readily decompose in the air by parting with carbonate of lime.

Iodide of zinc and *Bromide of zinc* form white crystals, which become liquid when exposed to the air; are soluble in water and alcohol, and decompose readily. They are not often employed in photography. The inclination which ZnI possesses to form double salts is interesting; we mention the NH_4 + ZnI and KaI + 2ZnI.

Iodide of cadmium (CdI), atomic weight = 182.7; it is obtained by heating cadmium-foil with iodine and water; the solution yields, on evaporating it, large six-sided plates. It can be fused, and is free from water; under the influence of light it easily turns yellow; dissolves readily in alcohol and water, and forms plates which have a lustre like mother of pearl; its reaction in solutions is acid; exposure to the air does not change it; it shows a tendency to forming double salts.

$$\left.\begin{array}{r}\text{KaI CdI} + 2\text{ HO}\\ \text{AmI CdI} + 2\text{ HO}\\ \text{NaI CdI} + 6\text{ HO}\end{array}\right\}\text{ according to Croft.}$$

Combined with oxide of cadmium, it forms iodic oxide, which is decomposed by alcohol.

Bromide of cadmium (CdBr + 4HO), atomic weight = 171.7; it is obtained in the same way as iodide of cadmium; crystallizes with four equivalents of water in needle shape, which decompose in the air; is easily soluble in water and alcohol, and melts and sublimes at a high temperature; it is apt to form double salts.

KBr + 2 CdBr + HO also KaBr + CdBr
and NaBr + 2 CdBr + 5 HO (Croft).

These double salts have not been exactly determined as yet, but the photographic practice seems to indicate that great solubility in alcohol and greater permanence are the characteristic features. This

is the reason why mixtures of cadmium and alkaline salts are preferred for iodizing collodion. Of all the iodizing salts those of cadmium are the most permanent. They would be employed exclusively if their acid reaction would not somewhat impair the sensitiveness of the preparations.

ACTION OF THE IODIZING SALTS.

When different kinds of collodion are mixed with different iodizing salts in equivalent proportions, we find very marked differences in their action, which we cannot expect *a priori*, and which relate, on the one hand, to the fluidity, on the other hand, to the permanency and sensitiveness of the preparation. Of importance are: 1, the physical actions which the salts exert on the collodion. It has been found that the alkaline iodizing salts (potassium, sodium, ammonium, and lithium) make the collodion limpid, while the others (CdI, ZnI, CdBr) make the collodion thick (some collodions, which have been prepared with an excess of sulphuric acid, become, on the addition of iodide of potassium, first very thick, and then all at once very limpid).

We notice a similar tendency of making collodion very fluid in some of the alkaline carbonates, which are frequently added to the iodizing salts. There are only four salts used in photography which have an acid reaction, namely, iodide and bromide of cadmium, and iodide and bromide of zinc. The others, which have been mentioned above, have an alkaline reaction. It is self-evident that for the former a thinner, for the latter a thicker collodion should be selected—*i. e.*, one which contains more or less pyroxylin.

2. *Permanence.*—In regard to permanence, collodion prepared with cadmium stands at the head of the list; it keeps a long time without turning yellow, while alkaline iodizing salts, in solution, decompose rapidly, and the collodion turns first yellow, next red, and becomes very limpid. The least stable salt of the kind is ammonium, next follows iodide of lithium, and finally iodide of cadmium. The bromine metals do not decompose as easily. The cause of the red color is the oxidation of the alkaline metals, on the one hand by ozone, which is frequently contained in the ether, on the other hand by nitrous acid from the pyroxylin. Sometimes the impurities of the salts are the cause, because they contain alkaline carbonates. The permanency of the collodion is increased when several salts are used for iodizing it; it is probably due to the formation of double salts, which resist decomposition longer (see above, Iodide of cadmium).

3. A third point is the solubility of the salts. Iodide of potassium, for instance, dissolves only very sparingly, and can only be used under certain conditions. A collodion containing equal parts of alcohol and ether (the former of 0.816) will bear for every 120 parts, 1 part of iodide of potassium (Hardwich); but when we add iodide of cadmium, a more soluble double salt will be formed, consisting of almost equal parts by weight of both the salts. Bromide of potassium dissolves still more sparingly. Collodion containing $4\frac{1}{2}$ ether and $3\frac{1}{2}$ alcohol will not take more than $\frac{1}{4}$ grain per ounce of bromide of potassium (Hardwich). A precipitate is easily formed when we add bromide of cadmium to collodion containing iodide of cadmium. *This is a second reason* for rejecting KI and taking the more soluble sodium and ammonium salts.

Li I and NH^4 I dissolve very readily; but their tendency to decomposition destroys the permanence of a preparation containing them; and they are not very easily obtained pure. Of the salts of bromine, the best and most soluble is bromide of cadmium; the next is bromide of ammonium, to which the author gives the preference.*

4. Finally, the photographic qualities have to be considered. These differences do not show themselves much with freshly iodized and pure collodions, which have been mixed with equivalent quantities of different iodine and bromine salts (Hardwich). Observe that a fresh iodide of potassium gives a stronger picture than iodide of ammonium, and the latter gives apparently a stronger picture than iodide of cadmium. The inferior intensity of the iodide of cadmium collodion pictures is probably explained by the acid reaction of the nitrate of cadmium oxide, formed in silvering. In course of time, however, the collodions will change, those containing K I and NH^4I changing the most rapidly; they become less sensitive and turn red and limpid, but will give, with extended exposure, sufficiently intense pictures.

The change in photographic sensitiveness takes place much more rapidly *simultaneously with an increase of the intensity*, in the presence of organic substances, such as nitro-glucose, grape-sugar; also with collodion which has been prepared at a high temperature and in a very diluted state.

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* The solubility of bromide of sodium is much increased by the presence of cadmium salts. According to two experiments, 30 parts of alcohol containing 0.7 iodide of cadmium and 0.7 iodide of sodium dissolved 0.233 bromide of sodium. While 30 parts of alcohol, containing 1.0 iodide of cadmium and 0.4 iodide of sodium, dissolved 0.317 bromide of sodium. With 1.4 iodide of cadmium 0.4 bromide of sodium was dissolved.

A collodion is called intense, if on development it yields a very dense and little transparent picture; sensitive on the other hand, means, when dark objects (shadows, details of dark dresses, etc.) are clearly indicated.

Both qualities do not run parallel; some collodions yield a very thin picture, but are very sensitive to dark rays, while others work very intense, but reproduce only the brightest parts of the object to be taken.

The best collodion is the one which is sensitive and intense at the same time.

One often finds that a collodion at first turns red, but becomes afterwards lighter. This is explained by the formation of organic reducing bodies, which absorb the iodine, which causes the yellow color.

It only remains to explain why generally a mixture of iodine and bromine salts is employed for salting the collodion.

In order to get a clear understanding about the main point—the sensitiveness of the collodion—I undertook a number of special experiments. I prepared three different kinds of collodion, to which were added equivalent quantities of chloride of cadmium, bromide of cadmium, and iodide of cadmium. They were sensitized as usual, and a white plaster of Paris cast, partially covered with black drapery, was "taken" with the different collodions. All the three plates were exposed equally long and developed with a solution of sulphate of iron.

The collodion containing iodine gave a very intense picture of the white plaster, but the drapery looked weak, and the outlines were indistinct.

The collodion containing bromine gave a clear but weak picture of the plaster, and did not show a trace of the drapery.

The chlorine collodion did not show a trace of the picture.*

According to the above the pure iodide collodion is photographically the most sensitive.

To complete the experiments a mixed collodion was examined.

Three different kinds of collodion were prepared: 1, a pure iodine collodion; 2, a collodion containing as much iodine as No. 1, and besides $\frac{1}{3}$ of a bromine salt; 3, a collodion with as much iodine as No. 1, and also $\frac{1}{6}$ of a chlorine salt. With these chemicals the plaster of Paris cast and drapery were taken under similar circumstances.

The iodine collodion gave again a very intense but rather "washed" picture of the plaster, and very little detail in the black drapery.

* This does not prove the photographic insensibility of the chloride of silver collodion, as with longer exposure a picture would certainly be the result.

The bromo-iodized collodion and the chloro-iodized collodion gave a less intense, but a clearer picture of the plaster, and much more detail in the black drapery. Some dark folds in the latter, which were scarcely visible in the picture taken with iodized collodion, became plainly visible with the mixed collodion.

Hence, it follows,

Pure collodion mixed with iodine is more sensitive *for strong lights* (plaster, etc.); mixed collodion is more sensitive *for feeble lights.* The latter is consequently employed when we wish to secure details in the shadows.

This refers, however, only to wet plates prepared in the ordinary way in the silver bath, and for acid development.

Dr. Schultz-Sellack explains the greater sensitiveness for shadow, perceptible in mixed collodions, by their greater sensitiveness for colors. In the spectrum, iodide of silver collodion is sensitive only for violet and indigo. Iodo-bromide of silver collodion, on the other hand, is sensitive for blue and green also. The shadows which receive their light by reflection from colored bodies are colored also—*i. e.*, they contain more green and blue rays than violet, and hence their greater action on iodo-bromide of silver. This theory is not free from objection. The action of green and blue rays on iodo-bromide of silver does not take place immediately, but only after a longer exposure, while the greater sensitiveness for shadows manifests itself instantaneously. The author demonstrated further, that a lens with a very small diaphragm, in other words, a lens feeble in light, furnishes with iodide of silver a weaker picture of an India-ink drawing than with bromide of silver. In this instance we cannot speak of color, and the author supposes that light has to act for a certain length of time before it overcomes the inertia of the atoms, and produces such vibrations as to separate them. (See also the action on chlorhydrogen gas in the chapter on Chemical Meteorology.)

The initial action takes place certainly sooner with iodo-bromide of silver than with iodide of silver. In the mixed collodion the more easily reducible bromide of silver induces the slower iodide of silver to a quicker decomposition, and it is the latter which, owing to its greater capacity to darken with the developer, makes this action photographically visible.

It was formerly generally supposed, that the sensitiveness of a collodion increased with the amount of salt contained in it. This, however, is by no means correct. The experiments of the author demonstrated that by increasing the amount of salt from $1\frac{1}{2}$ to 2.2 per cent., no perceptible increase of sensitiveness took place; that with a still

greater percentage of salt the collodion worked with greater intensity, but became less sensitive, and part of the iodide of silver was thrown out, forming yellow lines.

Zettnow demonstrated later that the increase of the salts increases the sensitiveness only up to a certain point, and that a further addition of salt lessens the sensitiveness (*Photographische Mittheilungen*, vol. 8, page 300). According to his experiments the sensitiveness increased up to a percentage of bromo-iodine salts of $1\frac{1}{2}$ per cent., and up to $1\frac{3}{4}$ remained stationary. The amount of pyroxylin in the collodion is of much more importance.

Zettnow recommends the above proportions as the most practical. Different quantities of pyroxylin give, however, different results, as is shown by the author's experiments. In regard to the proportion of iodine to bromine, the author found 5 equivalents of iodine to 1 equivalent of bromine the most advantageous for the making of sensitive collodion (*Photographische Mittheilungen*, vol. 9, page 239).

PREPARATION OF SALTED COLLODION.

The plain collodion must be mixed with the metals of iodine and bromine. Many photographers add the latter to the oily liquid. This is impractical; generally the salts contain small traces of impurities, which settle only very slowly from the collodion and necessitate a tedious decantation.

It is therefore much more practical to dissolve the salts of iodine and bromine by themselves in alcohol, and to add them after a careful, if possible, double filtration, to the decanted plain collodion.

Such a solution of the salts of iodine and bromine in alcohol is called an iodizer or sensitizer.

Of especial importance is the selection of the sensitizing salts. As for the formulæ that have been recommended for this purpose, their name is legion. It is not my intention here to furnish a collection of formulæ, although amongst the many recipes there are a great many good ones. When we try the collodions of different manufacturers and photographers, we will notice in their qualities very perceptible differences.

Some work *soft*, others weak—*i. e.*, they furnish pictures with much detail in the shadows, but few high lights; others work hard, but brilliant.

Some will yield an intense, others a thin picture. And still all these widely different collodions will give good results in the hands of a person who knows how to handle them.

It is possible to secure with a feeble working collodion a brilliant picture by an illumination rich in contrasts; and, *vice versa*, when we have a collodion which yields too much contrast, we may, by proper illumination, secure a harmonious picture. Also by the proper selection of the developer many errors may be equalized.

But any one who intends to apply the same manner of working to all the different collodions, will condemn much as bad which, in more skilful hands, would secure good results.

On the other hand, we cannot deny that, especially in this article, considerable capital has been made out of the ignorance of photographers, and collodion with the strongest sensitizers—lately even casein and rubidium—have been recommended as the photographer's "philosopher's stone."

On the presence of bromine depends the sensitiveness for dark rays —*i. e.*, details in the shadows and softness; while on the presence of the salts of iodine depends the sensitiveness for bright rays—*i. e.*, the intensity of the high lights; from this the conclusion has been rather rashly drawn that collodion works softer according to the proportion of bromine which it contains; but this is certainly not the case.

Late experiments of the author have demonstrated that a collodion containing 5 equivalents of iodide of cadmium and one equivalent of bromide of cadmium works softer and is more sensitive than a collodion containing double and four times the quantity of bromide of cadmium in proportion to the iodide of cadmium employed.

For testing collodion nothing is better than a plaster of Paris cast surrounded by black drapery.

For comparative experiments, the most exact coincidence in regard to light, silver bath, and developer, is of the greatest importance.

The following are the formulæ which we can recommend.

(A.) *Sodium collodion of Dr. Vogel.*

Iodide of cadmium, ...	1 gramme.
Iodide of sodium, ...	0.4 "
Bromide of sodium, ...	0.3 "

dissolved in 30 cubic centimetres of alcohol, filtered, and one volume is mixed with three volumes of plain collodion of the following composition.

Alcohol, ...	50
Ether, ...	50
Cotton, ...	2

This corresponds with 2–2½ per cent. of salt.

(B.) *Equivalent collodion of Dr. Vogel.*

18 grammes of iodide of cadmium, dissolved in 270 grammes of alcohol.
17 grammes of bromide of cadmium, dissolved in 270 grammes of alcohol.

Each solution is filtered by itself, and 5 volumes of the solution of the iodine salt are mixed with 1 volume of bromine solution, and 18 parts of 2 per cent. plain collodion.

We add the following formulæ of well-known photographers.

(C.) *Loescher & Petsch collodion.*

Cotton, ...	34 grammes.
Dissolved in	
Ether, ...	1560 "
Alcohol, ...	780 "

To which is added

Iodide of ammonium, ...	16 grammes.
Bromide of cadmium, ...	16 "
Iodide of potassium, ...	16 "
Iodide of cadmium, ...	6.6 "

These salts are first dissolved in 780 grammes of alcohol, and filtered.

(D.) *Kurtz collodion.*

Ether, ...	450 grammes.
Alcohol, ...	450 "
Iodide of ammonium, ...	5 "
Bromide of cadmium, ...	3.12 "
Bromide of potassium, ...	3.12 "

Better 3.64 bromide of sodium, or 2.5 bromide of ammonium, cotton 9.37 grammes.

We recommend here also to dissolve the above salts in ⅓ of the required alcohol, to filter, and to add it to the decanted collodion, which contains the balance of the alcohol-ether and cotton.

As soon as the sensitizing salts have been added to the plain collodion, it should be well shaken for a few minutes, and left to stand for at least twenty-four hours, with cadmium collodion for two days, when the collodion will give its best results. Perfect cleanliness of the bottles is to be observed.

For travelling purposes cadmium collodions (see above, B), are recommended because they keep longer with a good portrait practice. Where the keeping qualities on account of the rapid consumption are of less moment, collodion with ammonium salts may be used as well. If in any of the formulæ we wish to substitute another salt for an

iodide or bromide, this must be done in the proportion of their atomic weight; for instance,

166 dry iodide of potassium corresponds with 186 iodide of sodium, 145 iodide of ammonium, 182 iodide of cadmium, 134 iodide of lithium (free from water).

119 bromide of potassium corresponds with 139 bromide of sodium, 98 bromide of ammonium, 172 bromide of cadmium.

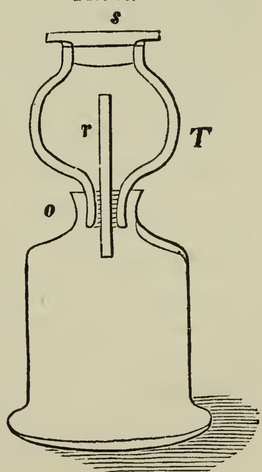
These proportions refer only to salts chemically pure. For the iodizing salts of the trade the proportions are somewhat different.

For instance, 10 bromide of cadmium corresponds with 6 bromide of ammonium, 6.8 bromide of lithium, 9.3 iodide of ammonium.

Generally the freshly mixed salts soon turn yellow, although the salts themselves are colorless. Later the yellow collodion sometimes becomes colorless again; this is no doubt due to organic substances, which absorb the iodine, the cause of the yellow color.

Generally, freshly mixed collodion will soon turn yellow, even if the sensitizing salts are colorless. Collodion containing salts of cadmium remains white longer than any other. Some collodions have a tendency to fogging previous to their turning yellow. This can be avoided by making the nitrate bath acid, or by adding to the collodion a few drops of tincture of iodine (which will at once impart a yellow color to it).* A collodion rich in alcohol is more apt to fog than a collodion rich in ether.

FIG. 58.



Some collodions will settle very slowly; after standing for months they will still give streaked and spotted plates. This is particularly the case when they have been made at a low temperature. Such collodion must be filtered: this is a tedious operation, which has to be performed with an apparatus especially designed for this purpose. The apparatus has a funnel, *T*, Fig. 58, which fits exactly into the neck of the bottle; the funnel can be closed by a ground-glass stopper, *s;* washed cotton is loosely packed around the glass tube, *r*. The collodion is placed in the funnel and drops slowly into the lower bottle, while the air from the same escapes into the upper one

* Tincture of iodine is made by dissolving 1 part iodine in 25 parts of alcohol.

by the small glass tube. The upper stopper, *s*, prevents the evaporation of the collodion.

How to use and how to take care of the collodion will be explained in a subsequent chapter.

2. THE NITRATE OF SILVER BATH.

The functions of the bath are to make the collodion film "sensitive"—*i. e.*, to change the iodine and bromine metals into iodide and bromide of silver. If we mix a solution of iodine or bromine salt with a solution of silver, iodide or bromide of silver will be precipitated. Any silver solution may be used for this purpose, but for photography nitrate of silver is the best, because it dissolves the most readily in water, and is obtainable most pure. Commercially it occurs in two different forms, the fused nitrate of silver in sticks and the crystallized.

In former times a diluted solution of silver 1 : 16 to 1 : 20 was used for the sensitive bath, and it is in fact suitable for that purpose still. But it is not advisable, however, to work with so weak a solution of silver, for the perfect sensitizing of the plates progresses only very slowly, and if the collodion contains a great deal of iodine and bromine, this will retard it still more; besides the bath loses with every plate a certain quantity of silver, and will soon be exhausted when the original percentage is very small.

Another point is to be observed,—the solubility of iodide of silver in a solution of nitrate of silver. This causes the so-called "eating away" of the film in a newly made bath, and to prevent that, one can either place into a freshly made bath a coated plate, and let it remain in it over night, or better, add at once a salt of iodine, which causes the formation of iodide of silver, and lessens the capacity of the bath to dissolve it out of the film.

I always use for the bath the neutral crystallized nitrate of silver; I never employ the fused nitrate, as it frequently contains silver combined with nitrous acid, which often gives rise to great annoyances.

I dissolve

100 parts of nitrate of silver in
1000 " distilled water,

and add 25 parts of a solution containing 1 part of iodide of potassium in 100 parts of water. I add 1 drop of nitric acid to 1 ounce of silver salt acid; only when a plate prepared in it appears veiled we add more; diluted nitric acid is then added drop by drop (1 part of nitric acid, 5 parts of water); but only just enough to make the veil

disappear. Mr. Black, the well-known photographer of Boston, uses a bath by far more acid, but we believe that such an acid bath affects the plate-holder injuriously, not to mention that the film leaves the glass very easily when the bath is very acid. I do not add acetic acid to the bath, as it is apt to give rise to the formation of crystals of acetate of silver; these are very sparingly soluble in the bath solution, and precipitate themselves on the plate in the form of spears, grains, or spots. The addition of sugar of lead, the metals of bromine, and similar salts, which has frequently been recommended, is perfectly superfluous. It must be mentioned here, that iodide of silver is less soluble in warm solutions of silver than in cold ones, therefore it happens in hot weather, that it precipitates it and causes the so-called pinholes. The bath should therefore be kept cool in summer; the best temperature is 66° Fahrenheit.

3. THE DEVELOPER.

As developer for the negative process, a solution of sulphate of iron is now generally employed. This precipitates the silver from its solutions as a fine metallic powder, and this precipitate is formed also when we pour an iron solution on a collodion plate which is still *wet from adhering silver solution.* When this silver solution is not present, for example, when we wash a plate before developing it, sulphate of iron will not develop a picture. This is the reason why with dry plates, when the silver solution is wanting we have to add it in order to develop.* In place of sulphate of iron we may employ

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* Only alkaline development, of which we will speak later, makes an exception with an old bath alcohol as above.

The peculiarities of glacial acetic acid and sulphate of iron have been discussed before.

In place of the expensive glacial acetic acid, we may as well take a small quantity of sulphuric acid. A developer of this kind we have used for years; we take

1200	grammes	water,
60	"	sulphate of iron,
3	"	sulphuric acid,
46	"	alcohol.

For reproductions, one-half the quantity of sulphate of iron is used.

In place of the sulphate of iron the sulphate of iron and ammonia is sometimes used; five parts sulphate of iron correspond with seven parts of iron and ammonia. This developer keeps for a much longer time than the other, which latter has to be made once a week.

The consumption of developer per $\frac{1}{10}$ square metres = one square foot, is 200–300 cubic centimetres or grammes.

any other reducing agent as pyrogallic acid, but for wet plates sulphate of iron is preferable. The precipitate forms only on those parts of the plate on which the light has fallen, and thus creates the picture.

In order that the precipitate may not form too rapidly and cause irregular deposits over the whole plate, a diluted solution of sulphate of iron is used. We also add acid.

To give acidity to the developer, acetic acid (so-called glacial acetic acid) is generally used.

According to later investigations of the author, acid has more the property to maintain the developer clear (a neutral developer soon becomes turbid and deposits base oxide of iron), than to retard the formation of a precipitate. The usually added acetic acid exercises still another influence; it makes the developer flow readily over the collodion film. Acetic acid is a substance similar to alcohol, and it facilitates the adhesion of water to the collodion. A pure watery developer is generally repelled by the collodion film and causes spots.

With an old bath containing much alcohol, this occurs more readily than with a new one. For this reason alcohol is generally added to the developer.

For pictures with half tones a concentrated developer is used; for reproductions we work with a diluted developer.

We take

(A.) *As developer for portraits and landscapes.*

6 parts of sulphate of iron,
3 " acetic acid (glacial),
100 " water.

When the nitrate bath is old we add two parts of alcohol. The water does not need to be distilled. Ordinary river water or spring water, provided it does not contain salts in too large a proportion, is sufficient.

(B.) *Developer for reproducing line engravings.*

2½ parts sulphate of iron,
3–4 " glacial acetic acid,
100 " water.

4. THE INTENSIFIER.

In many cases the developed picture is too weak for printing purposes; its strength must then be increased by intensifiers; this is done by pouring on the plate silver solution mixed with a reducing substance, as, for instance, sulphate of iron, or pyrogallic acid. From

this mixture silver in a powdered state will precipitate, and is attracted by the silver molecules of the developed picture, and increase its intensity.

As principal intensifier a mixture of acid solution of silver combined with a reducing liquid is used. For the latter a solution of pyrogallic acid is generally liked in the presence of acid; it works slowly, very clean, and gives a heavy film. But, like the developer, when dissolved in water, it will not keep long, as it absorbs oxygen and turns brown. The alcoholic solution, however, will keep for years. As the weighing of pyrogallic acid is more troublesome than measuring it, I generally prepare a stock-bottle for that purpose: take

1 part of pyrogallic acid,
10 parts of alcohol.

Dissolve and filter. When well corked this solution will keep for an indefinite length of time. For use, 4 cubic centimetres* are diluted to 100 cubic centimetres with water. Immediately before use a small quantity of it is mixed with an equal volume of the following silver solution:

2	parts of	nitrate of silver,
3	"	citric acid,
100	"	water.

This silver solution will keep from two to five weeks.

In summer-time, or when the pyrogallic acid (which sometimes happens) is more energetic, it will be advisable to take four parts of citric acid instead of three. In winter-time, when the reduction should prove too slow, the quantity may be reduced to one part. For the reproduction of line engravings, the intensifier should be kept very acid, in order to keep the lines clear.

The iron intensifier deserves the same recommendation as the pyrogallic acid. In the hands of inexperienced persons it is apt to give rise to spots; but it has the advantage that it does not require a washing of the plate before intensifying, and when the proportions are correct it works more rapidly.

We take the above developer (see above) and mix it with an equal quantity of the annexed solution of citrate of silver:

2	parts of	nitrate of silver,
3	"	citric acid,
2–3	"	alcohol,
100	"	water.

* 1 cubic centimetre = 17 minims.

Alcohol is only added, that the intensifier flows easier over the film. When the intensifier does not flow evenly over the film spots will be the result.

The other numerous intensifiers, which have frequently been recommended, we cannot mention here; many of them are interesting, but they have not proved themselves as possessing the same practical advantages as those which we have mentioned above. Some of them, which are valuable for some especial branches of photography, we will mention further on.

5. FIXING.

From the developed and intensified picture we must remove the sensitive material, iodide and bromide of silver—on the one hand, in order to make the plate transparent; on the other hand, to protect it against further changes through the influence of light; we take either a solution of

1 part of hyposulphite of soda,
4 to 5 parts of water,

or,

1 part of cyanide of potassium,
25 parts of water.

The solution of "hypo" will keep for several days. The solution of cyanide of potassium decomposes rapidly, and is transformed into potassium formate.

In the atelier, where an abundance of water is constantly at hand, we use hyposulphite of soda; but where the supply of water is limited, when travelling, etc., we use cyanide of potassium.

The latter also dissolves the silver of the picture, and destroys, when it is not quickly removed by washing, the delicate half-tones of the picture.

6. THE VARNISH.

The finished picture requires a covering to protect it against injury by mechanical influences.

Formerly a concentrated solution of gum Arabic was used for this purpose. This would be sufficient when only a limited number of prints are to be taken from the negative, and when the plate is not to be kept for any length of time. Plates which must be kept should be covered with a solution of a rosin in alcohol, consisting principally of shellac. There are as many varnish recipes as there are collodion

formulæ; but nowadays it is generally best to buy the varnish ready made from the stockdealer.

To those who wish to prepare it themselves we recommend the following recipe:

3	parts	white shellac,
3	"	sandarac,
40	"	alcohol of 95°.

Kilburn recommends a varnish which is said not to split or tear.

Alcohol, ...	1220	grammes.
Shellac (light yellow), . . .	180	"
Sandarac, ...	22	"

To thirty grammes of this solution one to two drops of castor-oil are added; this makes the varnish softer. With this varnish the negative is in an hour's time ready for the printing-frame.

Sometimes the varnish affects the collodion film injuriously; this is obviated by adding one per cent. of water.*

7. GLASS PLATES.

The glass plates form a most important substratum for carrying the collodion film in photography, and are used in enormous quantities. They require some preparation before they are suited for the delicate manipulations of the photographic processes. Conditions for their employment are,

a. As nearly as possible perfect transparency, so as to permit the light to pass through unchecked in the printing process. The white and clear plates always have the preference over green glass, or that full of bubbles.

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* Varnishes containing turpentine generally have this propensity.

The consumption of varnish per $\frac{1}{10}$ square metre = 1 square foot is $7\frac{1}{2}$ cubic centimetres or grammes.

An important quality of the varnish is whether it takes lead-pencil marks readily or not, *i. e.*, whether the plate can be retouched.

Sometimes a negative is coated with two films of varnish. On the first film, which bears the retouch, a second one is poured in order to protect the lead-pencil lines. The second film must not dissolve the first. We take for it amber varnish. To make it we melt yellow amber carefully in a covered dish, and dissolve in benzine. The solution requires sometimes more sometimes less benzine.

Others coat the finished negative with a solution of gum Arabic of the strength 1 : 10. When dry, the retouch is laid on this film and protected by a coat of varnish.

b. Smoothness.—Glass plates which are not absolutely level, will not make perfect contact with the plane of the picture in the camera, and still worse in the printing-frame. In the latter they are apt to break.

c. Cleanliness of the surface.—We generally find two kinds of photographic glass in the market—the so-called Rhenish glass and plate-glass. The former is a more greenish and not always exactly plane and smooth kind of glass; it is made in the same way as window-glass; it is first blown and afterwards flattened out. The other is blown also, but it is afterwards ground, in order to give it a perfectly plane surface.

For smaller pictures, the ordinary glass is good enough, particularly when in its manufacture attention has been given to flatten it with great care, and to store it in a clean place.

But when we require very plane plates, the much more expensive plate-glass should be taken; for instance, for large pictures and reproductions, which have to be mathematically correct. The surface of the glass requires attention. The ordinary Rhenish glass is harder than plate glass, and less exposed to injury from mechanical or chemical causes. Glass resists chemical influences much less than is generally supposed. Pulverized glass, when boiled with water, gives out a considerable quantity of salt; even when a small quantity of water is evaporated on a glass plate, we notice sometimes that the surface is attacked by it. Solutions of salt exercise a still greater influence, and we frequently notice that drops of water, which have dried on the glass, and salt solutions, leave an indelible stain.

We must convince ourselves that the plates are of suitable size, and will fit in the plate-holder.

The photographer buys his plates generally of suitable size, and very often they are packed with pieces of printed paper between them. This is a bad practice, for the printer's ink is apt to leave greasy spots on the plate, and sometimes the print can be read on the glass by breathing on it. Strips of blotting-paper, for separating the plates from each other, are much preferable.

The rough edge must be removed, as it would tear the cloth in cleaning the plates, and is apt to injure the hands; this is easiest done by drawing a flat file over the edge, or by rubbing the edges of two plates against each other. The splinters should be removed at once, as they will scratch the glass.

The greatest cleanliness in the treatment of glass plates is a condition of primary importance.

All the plates require very careful cleaning. The nature of the cleaning is partly chemical, partly mechanical.

The plate is dipped for a few hours in a solution of either

1	part of	raw nitric acid,
1	"	water,

which is kept in a dish; or,

1	part of	bichromate of potash,
1	"	English sulphuric acid,
12	"	water.

The latter mixture is recommended by M. Carey Lea. It destroys organic substances with great energy. Attention should be paid, however, to the fact that crystals of chromate of alum are apt to form and settle on the plates; when this takes place the mixture must be renewed, as it has become useless.

I generally use *nitric acid.*

When a plate is to be used at once, it should be rubbed carefully on both sides, stroke by stroke, with a rag dipped in the acid; after resting for a few minutes, it should be well washed with water, assisting with the hands.

The plates in order to drain are placed on pieces of blotting-paper, and finally rubbed dry with a towel or Canton flannel, which IS KEPT EXCLUSIVELY FOR THIS PURPOSE.

Some operators recommend cleaning the plates with caustic potash or cyanide of potassium. A solution of the strength of about 1 : 10 is rubbed on the plate with a linen swab; the plate is then washed and dried as described above.

A number of cleaned plates must be ready before photographic operations are commenced.

This cleaning should be done with the greatest care, as a plate which is not previously well cleaned can never be brought into the proper condition by rubbing it with chamois leather alone.

It must not be neglected to clean the rough edges also; this is very often overlooked and causes stains and dirty margins in the pictures.

SECTION II.

THE PHOTOGRAPHIC OPERATIONS.

When the preliminary work which has been described in the previous chapter has been performed in the laboratory and in the atelier,

the execution of the process may commence. *But we must first convince ourselves that nothing is wanting.*

Nothing happens more frequently to the beginner than that one thing or another has been neglected or overlooked. A plate has been cleaned, collodionized, sensitized, and exposed; but the developer is not ready; or clean glasses are not handy; or the intensifier has to be made; the plate dries, the film contracts, and the previous four or five operations go for nought.

Having a care to see that everything is in order, is of the *utmost importance in portraiture*, for the model as well as the photographer suffers from neglect. The former would have to go again through the disagreeable operations of posing, placing the head in the head-rest, sitting still, etc., and this is, for the public, little calculated to form an attraction.

The first work in making a photograph is the cleaning of the glass plate.

1. THE CLEANING.

We suppose that a number of plates, which fit in the plate-holder, and have been exposed to acid, washed in water, and dried with the towel, as described above, are at hand. Both sides should be examined by breathing on them; the least impurity will show itself by an *unequal adhesion* of the breath.

When both surfaces appear to be equally clean, the one which is most smooth should be selected for the reception of the picture. In the common glass, the two surfaces vary; the one which has been undermost in the oven, in flattening it, appears covered with numberless small specks, while the other is smoother. One side only requires to be finely polished, as only one side is collodionized; but the reverse side must not become dirty either, as the dirt would be transferred to the silver bath and injure subsequent plates.

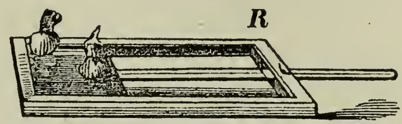
The first step in the final cleaning consists in breathing on the plate and rubbing it with a *perfectly clean towel*, which is used for *no other purpose* WHATEVER.

The polishing is done on a perfectly clean table, upon which no other substances than those necessary for cleaning are allowed.

It was formerly mostly done with alcohol, old collodion, and the like substances; much simpler, surer, and easier is the cleaning with ammonia as proposed by the author. It is said that a mixture of 1 part ammonia with 1 part alcohol is still more efficient. We use only watery ammonia.

The well-washed and dried plate is laid upon a flat board, or in a polishing frame, *R*, which is adjusted by a screw to the edge of the plate. For a carte de visite size, 4 drops of strong ammonia are poured upon it, and rubbed with a clean towel, which has been washed with soda (not soap), first, from right to left, next, from left to right, and lastly up and down. After this the plate is rubbed with a clean dry towel. We now breathe on the plate. When the plate takes the breath evenly, and with a blue color, everything is right.

Fig. 59.



Spots show themselves by the breath adhering unevenly to the plate. With beginners these show themselves often at the margin and in the corners, because they forget sometimes to clean them. Whenever spots show themselves, we should breathe on the spot, and polish with a dry towel. If this does not remedy it, we have to repeat the polishing with ammonia. Spots which do not disappear after this treatment are due generally to insufficient acidulation, or dried spots of silver solution. Such plates should be placed in the acid again. There are instances where these spots do not do any harm, but they are rare. Polishing with leather is not necessary.

The cleaning is an operation which has to be performed with skill, judgment, and care. The beginner generally commits the error that he tries to clean with the leather pads plates which have not received sufficient care in the acid bath and the preliminary washing. This is time and labor wasted. Dirty hands and towels, and dirty cleaning-rags, often cause much trouble.

Cases where the dirty coat-sleeve draws a line over the cleaned plate occur every day. Many forget also the careful cleaning of the edges and corners.

Very large plates are cleaned in sections. When the plate has been cleaned with the towel, the whole plate is rubbed over with large leather pads; and when the breath indicates spots which are not clean, they are treated separately.

Plates that have been used once before, and which are coated with varnish, are placed in a solution of soda. After a few hours the varnish film is removed. They are washed with water, next, with a little acid, then again with water, and finally they are treated like a new plate.

From plates that have been spoiled only a very short time ago, the film is easily removed by rubbing them over, and washing them after-

wards with water, when they are fit for use again. Plates on which the collodion has dried should be placed in acid. Old plates, which have been used over and over again, become finally useless; no cleaning will restore them. Many plates are irreparably destroyed by scratches—for instance, by carelessly placing them in the acid; by placing them flat on a table (the latter should never be done). The remedies which are frequently recommended to facilitate the cleaning, such as tincture of iodine, I do not feel like recommending.

Polished plates do not keep longer than twenty-four hours; if kept longer they attract so much water, that repolishing with towel and leather becomes necessary.

PRELIMINARY COATING.

Instead of polishing plates, it has been proposed to coat the same with other substances, as for instance, albumen, collodion, caoutchouc, etc. Coatings of this kind will form a clean surface even on a plate which is otherwise only polished with great difficulty, and they keep longer than a polished plate. We have tried the following film:

A. *Collodion.*—Dissolve 1½ parts collodion in 30 parts of alcohol and 70 parts of ether. After it has settled, the washed and dried plates are coated with it, and put away to dry.

This coating is sometimes dissolved when the iodized collodion is poured over it.

B. *Caoutchouc Solution.*—1 gramme caoutchouc is dissolved in 100 grammes of chloroform. This solution is effected in three to four days, the clear part is poured off, and diluted with nine times its volume of light petroleum benzine, and filtered twice. With this solution plates are coated the same as with collodion, after they have been washed, dried, and dusted. The excess of liquid which is poured off the plate is collected in a separate bottle, and after being filtered it can be used again. In a damp climate this coating is preferable to albumen.

C. *Coating with Albumen.*—This has been employed mostly in America, and generally with good results. The white of a fresh egg and two drops of carbolic acid are placed in a bottle with clean splinters of glass, and shaken for half an hour; the clear part is decanted from the froth, and diluted with its volume of ammonia. The concentrated solution will keep for six months. Before using it a portion is filtered, diluted with twice its volume of water, and filtered twice more. The glass plates are acidulated, well washed, and placed into a dish with clean water. If we wish to albumenize them, we pour a little distilled water over the plate to remove the wash water; afterwards a

few cubic centimetres of albumen solution are poured over the plate to remove the distilled water, and after draining the plate, the final solution is poured over it. The excess which drains off after coating is not collected. The plates are placed on a clean rack, and left to dry in a place perfectly free from dust.

In a dry climate they keep for months; per $\frac{1}{10}$ square metre = 1 square foot, about 20 cubic centimetres of albumen solution are necessary. Albumenized plates have the advantage that the collodion adheres to them very firmly, while from polished plates it is frequently removed in washing. To find which of the two sides of the plate has been albumenized, it is only necessary to breathe on the plate; the breath adheres readily to the glass, while the albumen film assumes rainbow colors.

Anderson proposes to add, in place of ammonia, glacial acetic acid.

2. THE DUSTING.

When a plate has been rubbed with the leather pads it generally becomes electrical, and attracts dust and fibres, which, if left on the plate, would spoil both collodion and nitrate bath. The plate is left on the drying-rack for a few minutes; it loses its electricity; it is now dusted off very carefully with a camel's hair brush (the duster).

It is best to hold the plate by one corner, in the left hand, in a vertical position.

The duster should not be laid on the table, but hung against the wall. The dusting should be done in the room next to the dark-room.

3. THE COLLODIONIZING.

The covering of a plate with an even film of collodion requires some practice. The beginner should try his skill on worthless plates with old and useless collodion.

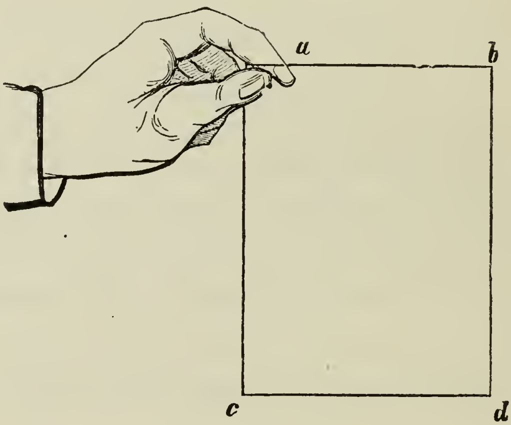
The glass plate (Fig. 60) should be held with the right hand perfectly horizontal by the upper left corner (*a*); a pool of collodion is poured on the centre of the plate; when a sufficient quantity has been poured on, the plate is gently inclined, that the collodion may first flow to the corner *b*, next to *a*, then to *c*, and finally to *d*. The plate is now inclined gently, by moving it in its plane around *d*. Under *d* the neck of the collodion bottle is placed to receive the excess of the fluid. The plate is now gradually, and while moving it constantly with a rocking motion, returned to the vertical position. The collodion evaporates while draining from the plate, and unless the latter be moved to and fro, it will dry in streaks (diagonal) in the direction

of the drainage. The motion should always be in the plane of the plate.

It is also important that the collodion does not collect on the back of the plate; by evaporation it causes unequal drying of the film, and besides imparts impurities to the bath by pieces of collodion becoming detached and floating in the bath. The collodion should not touch the fingers holding the plate, as it will dissolve fat from the skin, which may cause dark streaks in the picture.

The plate should be kept in constant motion, *and the collodion bottle should be closed again at once, a circumstance which is always neglected by beginners.*

FIG. 60.



To operators who desire to work very clean, we would recommend to collect the collodion which drains from a plate into a separate bottle; this prevents impurities from getting into the supply-bottle, such as dust from the plates, etc.

When the collodion becomes thicker, and the last drop has ceased to fall, care becomes necessary. When the lower corner has dried so far that the collodion will tear, then the moment has arrived for placing the plate into the silver bath. When the plate is dipped too soon, the film will become weak and peel off in washing. When it is dipped too late, the upper parts, which have become too dry, will either not become sensitive at all, or only superficially, and a dry border will be formed, which will show itself after silvering. It shows of course on the upper margins of the plate where the film is thinnest.

It is also important that the back of the plate be kept free from col-

lodion, as it causes by evaporation, and consequent cooling, unequal drying of the film. It also contaminates the nitrate bath by the peeling off of particles of the collodion.

As the handling of the plate with the fingers has its disadvantages, pneumatic plate-holders have been invented, consisting of small bags of rubber, which, when the air is pressed out of them, hold the plate. They often fail, and in hot weather the film over the holder dries slower, and the picture on this spot becomes thinner.

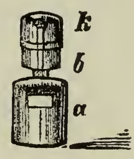
The coating of larger plates is somewhat more difficult. They cannot be held in the hand; they have to be supported in the centre. A corked bottle answers very well for this purpose.

We do not recommend the pneumatic holders; they very often fail, and the loss of a plate is the result.

Large plates are silvered also by placing them on a towel; the towel is formed into a ball; the plate is placed on it, and the collodion is poured on the plate; it requires some nice balancing to coat the whole plate evenly, and the beginner is likely to spoil a few plates before he becomes an expert; but it enables the operator to coat the whole plate without leaving out a corner, and for large-sized plates it is to be recommended.

It would not do to place the plate on the hand; the warmth of the hand would cause a more rapid evaporation of the collodion, and dry spots, where the fingers had supported the plates, would be the result.

Fig. 61.



Collodion bottles, constructed especially for pouring collodion, have been made, and in America they are known as the "Cometless" Collodion Bottle. The mouth is covered by a large cap, *k*, to exclude dust, and the excess of collodion is collected in the funnel, *b*, from whence it flows through a side opening back into the bottle, *a*. They are very good.

4. THE SENSITIZING.

Before we commence coating a plate, we must have the silver bath *ready and in good condition;* for, we have stated above, that the plate must be dipped at the moment it has reached a sufficient degree of dryness. Loss of time makes the result doubtful. The purpose oi placing the coated plate into the bath is to transform the salts ot iodine and bromine into iodide and bromide of silver. Although this process of decomposition is a very simple one, still there are some mechanical difficulties which sometimes prevent the production of a perfectly homogeneous film of these salts.

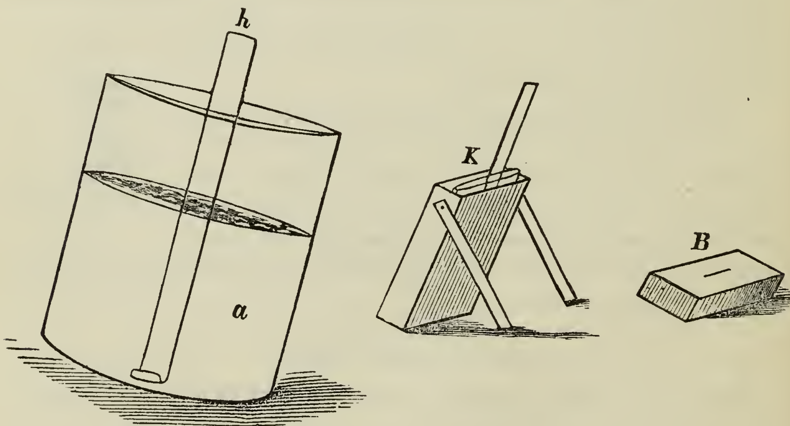
The collodion film is alcoholic; the bath is watery. Both repel each other at first, as grease and water would do, and this is the difficulty in getting the bath to flow perfectly even over the plate. Where the flow of the bath has been checked for a moment, streaks are the results. Several methods have been suggested to avoid this. We will describe at first,

a. THE SENSITIZING IN THE BATH.

The bath is a narrow glass trough corresponding in its shape with the form of the plate *a* (Fig. 62). The filtered silver solution is poured into it. The bath is generally placed into a wooden box of convenient form, and fixed in an inclined position. The box, *K*, is provided with a lid having a slit, *B*, in it. The sides of the bath, front and back, must be curved to prevent the tender collodion film from touching them.

Porcelain baths are inferior to glass; their opacity prevents us from examining the sides and the fluid to see whether everything is perfectly clean, not to mention the occasional peeling off of the glazing.

Fig. 62.



India-rubber baths, on account of the resinous organic matter contained in them, will in course of time affect the bath injuriously.

For *lowering the plate* into the bath an instrument, made either of glass or silver wire, called a *dipper*, is used; the lower end is bent so as to form a hook on which the plate rests. Glass dippers are easily broken. The best are those made of silver wire.

Gutta percha dippers are objectionable for the reasons mentioned above, when speaking of India-rubber baths.

Whoever wishes to use India-rubber goods (they are advantageous for travelling photographers, as they are not liable to breakage), should take care that the solution does not remain longer in contact with them than is absolutely necessary; they should also be washed very frequently.

For the purpose of sensitizing, the plate is placed on the dipper, the corner by which the plate has been held (see Fig. 60) being downward; the plate is lowered into the bath with a steady motion. Any interruption in this steady movement will produce lines, which cross the plate horizontally, and become visible after development.

The alcoholic collodion film repels at first the watery bath, and the latter runs off the plate in greasy lines when it is removed from the bath shortly after immersion.

The plate is moved up and down in the bath until the greasy lines disappear; when this has taken place, and not before, the plate is ready for exposure. With a concentrated bath, and in warm weather, the sensitizing progresses very rapidly; with a low temperature and a weak bath, the process is slow. A plate which has been exposed too soon will show, in the place of the greasy spots and lines, black spots and lines, when the developer is poured on.

The plate, when it is removed from the bath, is placed in the same position on pieces of clean blotting-paper, the top of the plate resting against the wall. In the intervening time, while the plate is draining, we place into the lower corners of the plate-holder small pieces of clean blotting-paper, not omitting, however, to wipe the corners first very carefully; and, finally, we place the plate into the plate-holder, taking care that the four corners are in their proper places, and that the corner which left the bath last occupies also the lower corner in the plate-holder.

All these operations must be performed in the dark-room with a non-actinic light; bringing the plate too close to a bright gaslight should also be avoided.

The greatest cleanliness of the hands and all and every object which comes in contact with the plate is absolutely necessary.

The sensitizing should be done on a table from which, excepting collodion, all the other chemicals are excluded, particularly hyposulphate of soda.

b. SENSITIZING IN DISHES.

This has the advantage that a *very small quantity of silver bath* will be *sufficient;* on the other hand, there is the disadvantage, that the

scum has to be removed from the bath *before every immersion of a plate;* after it has been used it has to be poured into a bottle, while in the upright bath the solution can be kept.

The sensitizing in dishes is more suitable for amateurs and small establishments; for large ateliers it is unpractical.

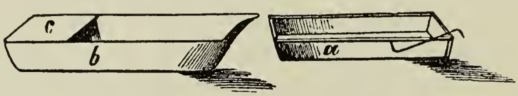
The dishes are made of the same material as the baths,—glass, porcelain, and gutta percha. We prefer the glass dishes (see *a*, Fig. 63) for the negative process.

The genuine square Japanese dishes, with rounded sides and corners, are excellent (see Fig. 64). They are light, do not break easily, and resist the influence of the chemicals very well. Before using, a solution of permanganate of potash should be placed in them for twelve hours.

The bath solution is filtered into the dish until it covers the bottom about one-quarter of an inch deep; the scum is removed by drawing strips of writing-paper over the surface until they appear to be free from dirt; the coated plate is now placed vertically in the dish, *the corner by which it has been held in coating being downward;* the front of the plate touches the side of the dish. The plate is now lowered, with a very steady motion, until it becomes entirely submerged, the coated side being downward.

The upper margin of the plate is seized with a hook of silver or bone (Fig. 63, *a*), and moved repeatedly up and down until, when

Fig. 63.



viewed in reflected yellow light, the greasy lines have all disappeared; the plate is finally removed from the dish in a vertical position and placed on strips of blotting-paper to drain off the superfluous solution.

When the quantity of fluid in the dish is too small, the solution is repulsed, and air-bubbles will collect on the plate and cause round spots when the developer is poured on.

If the amount of bath solution is small, the dish S, after the plate has been placed into it, should be tilted up with the left hand, as shown in Fig. 64. With the right finger the plate is lowered until it nearly touches the fluid, after this the right hand, and next the left hand is removed. In this way the bath will flow over the plate with one bound. The dish should afterwards be moved smartly so as to obviate any repulsion. The more energetically the dish is moved,

the more rapidly will the streaks disappear. In summer-time sooner, in winter later.

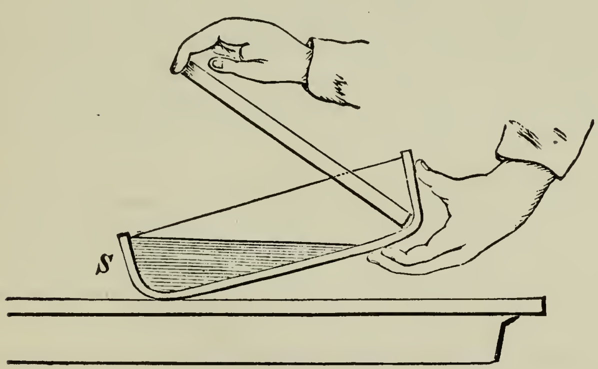
For this manipulation a plentiful supply of bath solution is therefore necessary. The plate is placed vertically in the dish as described above, but at the same time the dish is moved in order to hasten the flow of the liquid over the plate; when this is neglected we get very often a plate covered with curved sensitizing lines.

With this method the plate becomes sensitized very rapidly, as the alcohol can readily rise to the surface. The dish is moved until the greasy lines have all disappeared; the plate is lifted out with a rapid motion, so as to wash off small floating particles (pieces of collodion film, etc.). Otherwise we proceed as has been described above.

This method requires more practice, but in the hands of a skilful operator it gives the cleanest plates. For large plates this method is generally employed.

To facilitate the immersion, half-covered dishes have been constructed (Fig. 63, left figure); when such a dish is placed in a vertical position, the solution collects in the covered part, and by rapidly

Fig. 64.



lowering it, the whole plate will be quickly overflowed. It should be so arranged that the wave of the bath flows first over the thickest part of the plate containing the most alcohol, because here the repelling action is the strongest.

In regard to draining, etc., proceed as directed above.

The bath which is kept in dishes should always be carefully skimmed previous to preparing a plate; the dish should be kept carefully covered.

The best temperature for a bath is 66° Fahr. In hot summer weather, the bath is improved by placing it in a tub of cold water.

5. THE EXPOSURE.

Before placing the plate-holder with the plate into the camera, we should cast a glance over the object to be taken, and also on the ground-glass, to see if everything is in order. The ground-glass is next replaced by the plate-holder, taking great care that the apparatus does not change its position in the least. With equal care must the shutter of the plate-holder be drawn, and particularly for long exposures it is advisable to throw a black cloth over the shutter and plate-holder; when this has been done, the cap is removed from the lens as gently as possible so as to avoid moving the instrument.

How long shall I expose? is the question which we hear from every beginner, and sometimes the experienced operator is doubtful on this point.

The time of exposure depends on the *chemical intensity of the light, the brightness of the object to be taken, the amount of light which the lens has*, and on *the size of the stops employed.*

Many circumstances have to be taken into account at the same time; experience is the only guide; the only criterion which the photographer can employ is the examination of the picture on the ground-glass. According to its appearance after the picture has been sharply focussed and the proper stop inserted, according to the brightness which it shows on the ground-glass must he regulate the time of exposure.

For portrait and landscape photographers, it may here not be out of place to call attention to the enormous differences in the intensity of light in the different seasons. With a clear sky the light is at 12 o'clock, noon, on the 21st of December of the same intensity as at $6\frac{1}{2}$ o'clock in the evening on the 21st of June. Similar differences exist for all seasons. The study of the chemical meteorology is by no means of secondary interest.

During exposure due care should be taken that the apparatus is not shaken; moving to and fro must be avoided; the objective should be protected *against extraneous light.*

A box surrounding the objective or fastened to the stand will accomplish this.

This precaution is particularly necessary when the atelier is exposed to direct sunlight, or when we work with much top-light. In handling the plate-holder the vertical position should be maintained as much as possible.

It must be remembered that the plate is placed wet into the plate-holder; that the solution will collect on the lower margin; and when we reverse the position, the solution which has collected at the bottom will run back over the plate and generally produce stains.

The principal thing is to operate rapidly. The plate, particularly in warm, dry weather, will only keep moist for a short time; it is therefore necessary that every preparation should be taken beforehand, so that the plate may pass through the different stages rapidly and without any delay.

6. THE DEVELOPMENT.

The exposed plate is carried into the dark-room and placed in its original vertical position. Having satisfied ourselves that the developer, intensifier, fixing-bath, and clean glasses are all in their proper position, and the light in the dark-room being not too strong, the plate is carefully removed from the plate-holder, seizing it in such a manner that it is inclined towards the corner which was lowest in the plate-holder. This is done in the best way by opening the back of the plate-holder (D, Fig. 24), which is lying on the table; the plate-holder is then seized in such a manner that the thumb holds the lid and prevents its falling back, the plate-holder is then reversed, and the plate falls on the flat right hand. The plate-holder is now put aside (in order to be cleaned presently), and with the first three fingers of the left hand, the plate is seized by the corner which was lowest in the plate-holder and as shown in Fig. 60 (the same corner which was held in the hand while the plate was coated with collodion), in such a manner that the side *a, e,* is directed horizontally against the chest, and a little lower than the side *b, d.* Along this higher side *b, d,* the developer is poured. It will easily be observed that at the lower margin the surplus liquid has collected. This liquid must not run back over the plate, as it may cause streaks and stains, as has been explained above. The developer is therefore poured on the upper corner, with an even sweep, that it may cover at once the whole plate; a part will run off on the opposite corner and take with it the silver solution which may still adhere to it.

For the beginner it will be difficult to pour the developer evenly over the whole plate, as the watery developing solution is repelled by the alcoholic collodion film, and in the places where the flow of the wave has been arrested, lines will show themselves—the so-called developing lines—which no subsequent flowing with the developer will remove.

Neither must the developer be dashed on to the plate too energetically, as that generally produces a bright spot. By pouring the de-

veloper on too rapidly, the silver solution is removed from the place where the developer strikes the plate, and the picture-forming material is reduced in quantity; the pouring of the developer must be practiced before perfect results can be expected.

It is further to be observed, that the upper margin, upon which the developer is poured, must be coated with a film sufficiently strong to resist the shock; for this purpose I recommend placing the thickest part of the film (the part from which the collodion has been drained back into the bottle) uppermost into the plate-holder, and by following the above directions it will come in the proper position in the development.

When the developer covers the plate, the picture becomes visible. When this takes place too rapidly, then the plate has been overexposed; when it takes place very slowly, the plate is underexposed. With a normal development the high lights appear first; in a portrait, for instance, the white linen (shirt-bosom), etc., next the face and hands appear, then the light vest or pants, the furniture and draperies, and finally the dark coat. The appearance of the picture should be watched with the greatest care; the developer should be moved in every direction, and fresh solution should be added when necessary. The dark shadows must be watched (particularly the folds in a dark coat in a portrait, or the foliage in a landscape) to see if all the details come out properly. It is of course necessary to be perfectly familiar with the original in order to judge correctly. When in spite of long-continued development, the details in the shadows do not appear, then the plate has been underexposed, *and no subsequent operation will remedy this defect.*

An overexposed plate will show all the details in the shadows, but the contrasts which constitute the beauty of a picture are wanting. The plate is monotonous and yields similar prints.

The transitions from light to shade are, in an underexposed plate, generally too abrupt, or, as the photographers call it, they are hard.

Long experience is the only thing which will enable us to decide from the film with certainty, certainly when a plate has received the proper exposure.

When the plate has been fully developed, the developer is washed off, the back of the plate is washed with the hand, and the plate is examined carefully by transmitted light. When the plate is faulty, no further operation is necessary; the plate is simply cleaned and put aside. When, however, it appears clear and transparent in the shadows, with sufficient detail in the dark parts, soft in the half-tones, sharp, and free from spots, then it should be intensified.

7. THE INTENSIFICATION.

This is generally done with a solution of pyrogallic acid; the experienced operator will succeed, however, with the ordinary iron developer.

With a brilliant, intense light, some collodions will give pictures which do not require any strengthening; but in many cases we cannot well do without it.

A small quantity of the watery pyrogallic solution is poured into a clean glass, and an equal quantity of a solution of nitrate of silver is added; the mixture is at once poured upon the plate; by moving it to and fro the liquid will spread over the whole plate, leaving no spot uncovered; after a little while the intensifier is poured back into the glass, while at the same time the plate is examined by transmitted light. The spots on the back of the plate, which are easily removed with the finger, must not mislead us.

When the plate has reached the necessary density (the determination of which is purely a matter of experience), the intensifier must be washed off at once; if the plate has not reached the necessary density, the intensifier is poured on again, provided that the liquid is still clear; a brownish tint does not hurt.

If it has become turbid, it must be rejected, and a fresh solution of pyrogallic acid and silver is poured on.

Sometimes a bluish precipitate will form in the shadows; when this takes place it is an indication that the intensifier is not sufficiently acid, and more of the latter must be added.

When the plate has reached sufficient density, and has been washed thoroughly, it is ready for fixing.

When we intensify with iron solution, equal to twice as much nitrate of silver solution should be mixed with the iron, and poured upon the plate, after development, without previous washing.

The intensification progresses as rapidly and comfortably as with the pyrogallic acid solution. Sometimes, however, the intensifier does not mix readily with the developer which may still remain on the plate; the liquid containing the most alcohol will repel the one containing the least; this must be remedied by giving an equal quantity of alcohol to both. When this is neglected, spots are likely to result.

With landscapes and portraits intensifying is comparatively an easy work. With reproductions, however, as for instance copies of drawings, it requires more time and great care. The fine lines become easily veiled, or the plate is unequal, when the intensifier has not covered the whole plate equally.

The place on which the intensifier is poured becomes first generally a little darker, a circumstance which in portraiture can be turned to advantage by pouring the liquid on the head, and thus giving to it additional density.

The beginner should remember that the intensifier makes the plate only denser and richer in contrast, but does not add to the details. It is, hence, useless to try to improve an underexposed plate by intensifying it.

Concerning intensification, after fixing, we will speak further on.

8. THE FIXING.

When the intensified plate has been washed (sufficiently to remove the remnant of silver solution), and when the back has been rubbed clean, a solution of hypo or cyanide is poured on, as before explained.

Either solution dissolves the iodide and bromide of silver out of the film by forming double salts.

The cyanide of potassium affects the plate a little, because it dissolves in the presence of oxygen the gray silver forming the outlines of the picture.

This is of advantage for plates where the intensification has been carried too far, but for thin negatives it is a disadvantage. In the latter case close watching is necessary, and when the last trace of iodide of silver has disappeared, the plate should be washed at once with water.

Hyposulphite of soda does not affect the plates, but its action is slower than that of cyanide of potassium. When the solution is old or very diluted, in flowing it unevenly over the plate, it is apt to form black lines, the so-called fixing lines.

It is necessary to wash the fixed plates thoroughly in water to remove the soda, or it will afterwards decompose in the picture and cause its destruction.

Plates which have been fixed with cyanide of potassium are easier washed. The proper point is ascertained by placing a drop of the water, dripping from the plate, on the back of the hand and tasting it. The smallest quantity of cyanide will indicate itself by imparting to the water a bitter taste.

(Poisoning is not to be feared unless a person is exceedingly careless; but the liquid should not be tasted until the plate has been washed for some time. Be very careful.) After fixing, the washed plate is placed on clean blotting-paper to dry.

9. THE INTENSIFYING AFTER FIXING.

It has frequently been recommended to postpone the intensification until after the plate has been fixed. When we attempt this in the ordinary manner, with silver salt, we will always find that, unless it has been washed very carefully after fixing, the plate is apt to become spotted.

This circumstance makes this mode of intensification objectionable.

For intensification after fixing, a number of peculiar *metal salts* have been proposed, which, with the metallic silver of the picture, cause peculiar decompositions, and form pictures of different composition, which offer greater resistance to the passage of chemical rays. The chloride of mercury we mention particularly, also a solution of iodide of mercury in iodide of potassium, also a mixture of red permanganate of potassium and the oxide of uranium. These methods may be of advantage for special purposes, as, for instance, the production of negatives for the photo-lithographic process. For the ordinary photographer, however, the silver intensifier is preferable, the more so as the permanence of the plate produced by the other methods has not been established as yet.

Of particular importance, however, are these changes in the chemical composition of the film for the email or enamel process.

10. THE VARNISHING.

The delicate picture on the collodion film would soon be ruined by mechanical injuries (scratches, etc.), if we did not provide it with a covering offering more resistance.

Such a covering is the varnish. The loose particles of the film on the margins of the plate are first removed; the plate is warmed over a lamp, and the varnish is poured on exactly as the collodion is poured on in coating a plate; the excess of varnish is poured back into the bottle, and the plate is placed on paper and left to dry. The back of the plate should be kept clear from varnish, as it will produce unequal drying of the film.

If the plates are too hot, when the varnish is poured on, the plate is apt to become streaked; if too cold, the film will appear dull and less transparent.

Sometimes the varnish will eat away parts of the film; this takes place when it contains too strong an alcohol or turpentine, which dissolves the collodion film. One per cent. of water added to it and

warming till the precipitate caused by the water is redissolved, will remedy this.

Beginners generally make mistakes in varnishing. Glad to have finished a plate so far, they become careless in this last finishing operation, and spoil many a plate in varnishing.

After varnishing and drying, the backs of the plates are carefully cleaned and put away in boxes or closets, secured against dust and moisture.

Sometimes the collodion film cracks on drying the plate; this takes place particularly when the film is too thin, or with old plates which have not been polished well.

Very old collodion shows the same properties. If such cracks show themselves, the film may be treated while still damp with alcohol of 80 degrees, and varnished cold. When dry, a second coat of varnish is applied.

SUCCESSION OF THE DIFFERENT OPERATIONS

IN THE

NEGATIVE AND POSITIVE PROCESSES.

SECTION I.

THE NEGATIVE PROCESS.

a. PREPARATIONS.

Placing the plates in acid. Washing and drying, or albumenizing.
Filtering the silver-bath and removing the scum.
Making the developer, intensifier, and fixing solution.
Dipper, plate-holder, clean glasses, and filtering-paper should always be in readiness.
Preparation of the model and the camera (focussing).

b. OPERATIONS.

Cleaning the plates (with ammonia and towels).
Dusting (the duster not to be placed on the tables).
Pouring the collodion (the collodion must not be shaken, and the bottle must be re-closed immediately).
Drying the film (until the last drop commences to congeal, and the film on the corner, where the collodion has been poured off, tears in patches).
Immersion in the silver-bath (the corner by which the plate has been held, should be immersed first, and when the silvering is done with a dish, the liquid should be scummed before every immersion).
Moving the plate in the bath (until the greasy lines have disappeared).

Taking the plate from the bath and draining on clean blotting-paper.
Placing pieces of blotting-paper in the plate-holder.
Placing the plate in the holder.
Closing the holder.
Carrying the plate to the atelier (holding the holder vertically).
Readjustment of the focus (to see if anything has been changed).
Placing the holder in the camera (without shaking).
Opening the shutter (carefully).
Exposure (opening and closing the lens without shaking the camera).
Closing the shutter (easily).
Carrying the plate to the dark-room (vertically).
Pouring the developer into a small glass (as directed).
Taking the plate from the holder (cautiously).
Pouring the developer on the upper corner of the plate (moving the plate and controlling the development).
Short washing.
Intensifying (continually watching, by transmitted light).
Short washing.
Fixing.
Long-continued washing.
Drying.
Warming the plate.
Varnishing.

These are the twenty-eight consecutive operations which have to be performed with perfect accuracy when we wish to obtain a perfect picture.

SECTION II.

THE CARE OF THE PHOTOGRAPHIC APPARATUS AND THE CHEMICALS.

In the previous chapter we have especially explained the practice of the negative process, the arrangement of the apparatus, the composition of the chemicals, and all the precautions and little tricks which are necessary for the successful practice of the various photographic processes.

If the relations, under which the respective operations are carried on, would always remain the same, it would hardly be necessary to add anything to the previous chapter. But all things in this world

are subject to endless variations, and this general law extends of course to photographic apparatus and chemicals. Unfortunately, these changes are generally for the worse instead of for the better, and necessitate a constant mending and doctoring to keep the respective articles in their proper condition. The labor necessary to accomplish this end, we will condense under the title *care*, and we will commence with

THE CARE OF THE PHOTOGRAPHIC LENSES.

Of all the necessities of the atelier, the photographic lenses appear to be the most lasting, excepting of course their liability to breakage. However, they are also exposed to danger, particularly through the influence of dust. This substance penetrates through the slit for the stops into the interior of the tube, collects on the lenses, and absorbs of course a portion of the light. Openings through which dust can penetrate should be kept closed as much as possible. The objectives should occasionally be taken apart, and the surfaces of the lenses should be cleaned with soft leather. Sometimes the interior black mounting of the lenses suffers; the black coating rubs off, becomes glossy, and gives rise to unpleasant reflections. The bright spots should be brushed over with a solution of shellac to which lampblack has been added.

It must be remembered that flint-glass is softer than crown-glass, and must be handled with greater care.

CARE OF THE CAMERAS.

The photographic cameras, as well as the lenses, are exposed to the injurious influences of dust. Frequently, when the bellows are pushed in, a quantity of dust escapes from the interior, which collects on the plate and gives rise to holes and spots. Frequent dusting with duster and bellows is here necessary.

The *plate-holders* are the most exposed to injury and destruction. The silver solution from the moist plates drips from the plate, collects on the holder, penetrates into the wood, and causes decomposition. Many peculiar organic substances are thus formed, which dissolve in the liquid which drips from a new plate, and on long exposure penetrate into the collodion film, and on development give rise to the so-called "mossy" spots.

This phenomenon manifests itself most frequently with composition corners, as these offer to the silver solution a wider road into the interior of the wood than corners of solid glass or silver wire. The

lower corners of the plate-holder are particularly exposed to this influence.

To prevent the saturation of the plate-holder with silver solution, it is best to dip the lower corners of the holder into melted paraffin, or to varnish them with asphalt varnish.

The perfectly dry and clean corners of the plate-holder should be dipped for five minutes into melted paraffin; this preserves the wood to an extraordinary degree.

When we wish to prepare old plate-holders in the same manner, the silver solution, which has previously penetrated into the wood, must first be removed; for this purpose the lower corners of the holder should be immersed for from five to ten minutes in hot water; after this they should be carefully washed under a spigot, dried, and afterwards immersed in melted paraffin.

When the holders have completely cooled, the superfluous paraffin should be scraped off.

Remele recommends, in place of paraffin, the varnishing of the holder. This mode of preservation, however, has to be repeated monthly, and it only forms a substitute where paraffin is not accessible.

The utmost cleanliness is necessary for the preservation of the plate-holder. After every exposure, the adhering liquid should be removed with blotting-paper, and the holder should be frequently washed under the tap.

New holders give trouble very often by the detachment of small particles of wood or varnish, and do not become perfectly reliable until all these particles have been brushed away by continued practice.

All the wooden parts of the apparatus should be provided with brass strips to prevent warping.

In hot summers the very best of apparatus will warp. Placing moist blotting-pads inside the cameras, or covering them with moist cloths or blankets, is the best remedy, and it is particularly recommended to landscape photographers.

CARE OF THE GLASS PLATES.

Fresh plates are generally stored away with layers of paper between them. But even the best paper is not clean enough, and leaves an impression on the plate when it remains sufficiently long in contact with it.

For preserving polished or albumenized plates, the plate-boxes are used; the sides of these boxes are furnished with grooves, *f*, *f*, Fig. 65, in which the plates are placed. Care should be taken to keep the grooves as clean as possible, and that they are wide enough to give the plates some play. We sometimes meet with plate-boxes at the stock depots which are large and high enough, but the grooves are so narrow that a thick plate is only pushed into it with difficulty, which often causes breakage. A disadvantage is that finished and varnished collodion plates and dry plates easily become rubbed off by inserting them into the boxes. In England, metal boxes with grooves that have an acute angle are much in use, and these are free from the above disadvantage (see *Z*, Fig. 65). It is self-evident that the prepared surface has to be placed in the direction *a*. About plate-boxes becoming soiled, see remarks thereon. Instead of them we can use strips of pasteboard for the finished negatives; they are bent thus: ΛΛΛΛΛΛΛ. The plates are placed between two such strips as shown in Fig. 66, and tied together.

Fig. 65.

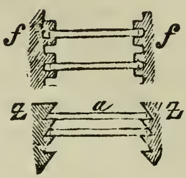


Fig. 66.

Plates that have been cleaned, and are not used the same day, should be rubbed over with chamois leather before they are used.

Cleaned plates for travelling should be packed with margins of pasteboard, when no plate-boxes are at the disposal of the photographer. Such margins are easily made, and the centre of the plates will be protected.

Great care should be taken not to scratch the plates. They should never be laid flat on the table, and they should only be rubbed with cloths which are perfectly free from dust. We should never forget to clean the rough margins. Plates that have been used once before require a different treatment.

When the picture on being developed proves useless, the plate should be cleaned at once, dried with a towel, and re-polished.

Plates over which the chemicals have been poured should never be allowed to dry. By permitting salts or even water to dry upon them, they may become affected to a degree that even an immersion in acid or caustic soda will fail to clean them.

Fixed plates, that have not been varnished, should be placed at once into nitric acid.

Varnished plates, that are unfit for use, should be placed for twelve hours in a concentrated solution of carbonate of soda; they should

then be washed, and when the film has become perfectly loose, the plates should be placed for a short time in acid previous to being cleaned. By the abrasion of the corners of the plates, a deposit of glass-sand will form at the bottom of the dishes, which will scratch the plates; it is, therefore, better to place flat pieces of wood at the bottom of the dishes, and to let the plates rest on them.

When immersing and when removing the plates care should be taken not to scratch them.

CARE OF THE COLLODION.

Collodion forms the basis of the photographic negative pictures; it is for the photographer of more importance than the paper for the draughtsman. It not only acts mechanically by fixing the sensitive film to the glass, but also chemically by containing besides the indifferent pyroxylin a whole line of products of disintegration, which have a material influence on the chemical and physical properties of the film.

The care of the collodion is consequently of much importance for the photographer who desires to secure equal results always.

The changes which iodized collodions suffer manifest themselves by a change of color, first yellow and then red, and by a decrease of sensitiveness. In these changes free iodine, which remains dissolved in the collodion, separates from the liquid, and gives rise to the formation of free nitric acid in the bath, which will impair the sensitiveness of the plate.

The salts of cadmium have the least tendency to turning the collodion red, while the salts of ammonium have the greatest. While the collodion turns red, it becomes more fluid, and finally so limpid that it does not secure a homogeneous or tenacious film.

It has been recommended to shake collodion which has turned red, with carbonate of soda, respectively with metallic cadmium, and to let it settle. These bodies will absorb the iodine and restore the bright color of the collodion, but at the same time the plates will have a tendency to fogginess, probably in consequence of the formation of alkaline salts, which are partially soluble in collodion, for instance CdI and CdO.

It is much more preferable to mix the red collodion with cadmium collodion. The latter will remain white for months; it is somewhat thick, and by mixing it with red collodion we will get the desired consistency and color very often.

Any one who works with cadmium collodion exclusively will very

seldom or never complain about red collodion. For other mixtures which have a tendency to turning red, it is recommended to preserve the plain collodion and the iodizer separately.

In this case the fluids are mixed in such quantities as experience has taught will be consumed in a short space of time.

Besides the disengagement of iodine a change in the proportion of alcohol and ether takes place, as well as the introduction of impurities, such as dust, etc.

The excess of collodion which has been poured on the plate is generally returned to the bottle. But this excess has lost a part of its dissolving media by evaporation, and of course more of the fugitive ether than of the less fugitive alcohol.

Hence, what is poured back into the bottle is thicker and richer in alcohol. With very careful management this does not matter much; under favorable circumstances a bottle of collodion can be used all but a very small remnant. And if this remnant should be too thick, it should be diluted with $\frac{1}{10}$ of ether.

But much more annoying than this loss of fluidity is the accumulation of dust and other impurities. Small traces of dust are washed into the collodion-bottle with the excess which is returned from the plate; with every plate this quantity is increased, and finally the collodion will work uneven.

This is more frequently the case when travelling, where we have to contend more with dust than at home; the annoyance is increased also with larger plates.

The rough corners of the plates exercise a very injurious influence, as they form receptacles for dust and other impurities, which is only too easily overlooked and returned to the collodion. It happens quite frequently that the grooves of the plate-boxes are filled with impurities, all of which help to spoil the collodion.

All these evils can be avoided by returning the excess of collodion to a separate bottle; this collodion is by no means useless; it should be left to settle for a week or so, and the pure liquid can then be decanted and used.

That the neck of the collodion-bottle should always be kept clean is a matter of course. A bell-glass should be placed over the stock-bottle. When no special collodion-bottle is employed, the neck of the bottle should be kept perfectly clean by wiping it with the finger, and the first few drops should be thrown away before pouring the collodion on the plate.

The bottle should be corked immediately after the plate has been collodionized.

THE CARE OF THE SILVER-BATH.

A correctly prepared silver-bath can be kept in good order for a long time with careful treatment. The conditions are to keep it as nearly as possible free from mechanical and chemical impurities. The former present themselves very soon in the shape of detached pieces of the film and dust.

Frequent filtering is consequently a matter of course, and still it does sometimes happen that this does not purify a bath, but has just the contrary effect. A photographer of my acquaintance tells me of such a case. He unfortunately employed a filtering-paper containing a large quantity of the salts of sulphuric acid.* These are thrown into the bath and give rise to the formation of sulphate of silver, which attaches itself in needle-shaped crystals to the plate, and causes spots.

A very pure filtering-paper should be selected. Sometimes a greasy film remains on the surface after filtering. In dishes this does not escape observation as easily as in the bath. The film should be removed with strips of writing-paper, which are drawn over the liquid.

If a silver-bath did not suffer any other damage in the preparation of the plates than the loss of silver, it would be possible to use it to the last drop, similar to a positive bath; but this is unfortunately not the case.

Every collodion, besides the salts of iodine and bromine, contains pyroxylin, and also the organic products of decomposition. With every plate a quantity of these, as well as alcohol and ether, is left in the bath, and after awhile it will contain, besides the salts of silver, the salts of cadmium, alcohol, and ether, the organic products of decomposition from the collodion and iodide of silver, and acetic acid, formed by the oxidation of the alcohol.

No wonder then that it changes rapidly; that it soon ceases to yield strong and vigorous plates, and furnishes weak negatives instead. Finally a point is reached, where the iodide of silver, which has collected in the bath, collects on the plates and gives rise to pinholes. This occurs particularly in summer-time with a high temperature.

When such a bath is tested for the amount of silver which it con-

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* To test the paper for these substances, it is necessary to soak it in water, to pour off the clear liquid, and to add a solution of nitrate of baryta; when the salts of sulphuric acid are present, a precipitate of sulphate of baryta will be formed.

tains, it is generally found to be very rich in that substance, having often not lost more than one-half per cent. apparently.

It is evident that such a bath could be restored to its former usefulness if we were able to remove the above-enumerated impurities.

Want of sensitiveness is occasioned by the amount of acetic acid which forms in course of time in the bath from the alcohol and ether acid, or by the presence of organic matters. Acid can be remedied by neutralizing the bath. Formerly the oxide of silver was frequently used for this purpose. This, however, should be rejected, as its action is too slow. Carbonate of lime is not to be recommended either, when it is employed in excess, as is generally the case, for it precipitates a portion of the silver. The best remedy is to employ pure carbonate of soda.

One part is dissolved in ten parts of water, and this is added drop by drop to the bath. A precipitate is formed which, on agitating the liquid, will disappear again completely; a second drop is added, and so on until the precipitate will no longer disappear on shaking the bath.

When the bath is now tested, we will find that its reaction has become slightly alkaline. It is filtered, and to the filtrate one or two drops of diluted nitric acid are added (one part acid to five water); a plate is now taken, and if it shows any fogginess, more acid is added, until the plate becomes clear.

This method of testing appears somewhat complicated, and some may think that litmus-paper would answer as well; but this is not the case. With the latter we often get too much acid in the bath.

When an old bath commences to yield weak negatives or to give insensitive plates, which besides have a tendency to show lines and streaks, it generally contains organic substances. In such a case the addition of soda would not do much good, for it would not remove the organic substances. Photographers usually neutralize the bath, and place it afterwards in the sun. This is very good when we have plenty of sunlight; unfortunately, however, this is not always to be had, and the perfect purification is slow, requiring sometimes a whole day.

Under these circumstances permanganate of potash, which was first proposed by Dr. Jacobsen, is preferable; it was first tried by Mr. E. Crooks.

This splendid preparation has lately been brought into the market in beautiful black crystals, which, when dissolved in water, impart to it an intensely deep red color. The solution itself is *sensitive to light*, and decomposes slowly, forming a brown precipitate (peroxide of

manganese). Organic substances discolor the liquid rapidly; the former oxidize, and the permanganic acid is reduced to peroxide of manganese,

$$Mn_2O_7 = 2MnO_2 + O_3,$$

which separates with brownish color. This decomposition takes place already in filtering through paper.

This property of destroying organic bodies makes this substance very valuable in removing organic matter from the bath. One part of the permanganate is dissolved in fifty parts of water. From this solution is added at first one drop to the bath which is to be restored. If it contains much organic matter, the first drops will almost immediately be discolored: it is then added in drops again and shaken, and so over again until the last drop is no longer discolored, and the bath assumes a slight rose tinge, which will last for about a minute (after a longer period the tinge from the permanganate will always disappear). Too much permanganate injures the bath.

When a great deal of organic matter has accumulated in the bath, a brownish color will be perceptible beside the rose color; the former is occasioned by peroxide of manganese.

The bath is now filtered. When only a little of the permanganate has been used, it will generally work well without further addition.

When a large quantity has been added, the potash will act as a neutralizer, and one or more drops of nitric acid have to be added, until all tendency to fog has disappeared.

In some cases, by the treatment with permanganate of potash, the organic substances have been oxidized, but not destroyed; if so, the organic matters may be destroyed by evaporation of the bath, and the melting of the solid residue. This work we do not recommend; better change such a bath and make a positive bath from it, and take a new one in use.

Evaporation is best done in a porcelain dish over a Berzelius (alcohol) lamp, or a gaslight.

As soon as all the water has evaporated, the silver salt becomes a tough mass, from which reddish fumes escape. The gray color is caused by precipitated metallic silver. The dish is now allowed to cool; the solid salt is dissolved in a little water placed on the fire, and when it boils, a few drops of nitric acid are carefully added. The cloudy mass on being heated will all at once become as clear as water.

Evaporate once more to dryness, and heat carefully to the melting-point; let it cool, and now dissolve the salt in ten parts of water.

When the bath gives veiled pictures, acid should be added, as has been described above.

Another impurity of the bath is an excess of iodide of silver, which forms most readily in a high temperature. Iodide of silver does not separate as easily from a warm solution as from a cold one. When the crystals are large, they form a mealy covering, and the plate will show numerous yellow spots after development; when they are small, they give rise to pinholes.

To remove iodide of silver, the bath should be diluted with thrice its volume of distilled water, and well shaken. The iodide of silver, which is only slightly soluble in the diluted bath, precipitates almost entirely. It will only be necessary to filter the liquid, and to evaporate it down to the original volume. Very often the bath contains an excess of iodide of silver and organic substances; in this case it should first be diluted, filtered, and treated with the permanganate.

In the presence of organic substances, the iodide of silver will separate much more rapidly than without it.

Another method to restore a bath which precipitates iodide of silver, consists in adding to the bath a fresh solution of silver, free from iodine, and of the same strength as the bath. In warm weather this will answer for a short time only. It is best to prevent the precipitation of iodide of silver by maintaining the bath at a low temperature. This can be done by cold water or ice, or, when neither is handy, by wrapping the bath in a dark, wet cloth, and exposing it to a current of air.

These are the most important methods of taking care of the bath. One impurity, however, cannot be removed by them, *i. e.*, the products of the decomposition of the salts of iodine, the salts of cadmium, and alkalies combined with nitric acid; when these are present in perceptible quantities, not one of the methods mentioned for restoring the bath will work satisfactorily, and it will always produce pictures weak and without delicacy.

In such a case it is always best to remove the iodide of silver, as has been explained above, by diluting it with twice its volume of water; next to evaporate it till dry, and melt as abovementioned. The dry salt is dissolved in 8–10 parts of water, and used as a positive bath. This is much more rational than the ordinary way of throwing such baths into the waste-barrel for reduction.

The practical photographer will do well to have always two silver baths on hand (one for present use, the other as a reserve in case an accident should happen to the first), and very often it is preferable to

make a new bath, as generally speaking a "doctored" bath does not work as well as a new one.

In many instances the use of two negative baths is advisable, an old one for silvering the plates, and a new one into which the silvered and well-drained plates are dipped. The plate receives in this way a coating of pure silver solution, and gives a finer picture than with the old bath alone. In course of time the second bath also becomes contaminated, and after awhile the second bath takes the place of the first, and a new one is made. The used-up first bath is used for a printing bath.

CARE OF THE DEVELOPER.

The protosulphate of iron in solution will soon turn red, in consequence of the formation of an ineffectual oxidized salt. Such a red solution contains consequently a less quantity of the active salts of iron than one that has been freshly prepared. This is an advantage when we have to develop pictures without half tones. For this purpose an old developer is to be preferred, but for plates with half tone, as for instance portraits, a freshly made developer is the most advantageous. When a developer has to be kept for a long time, as in travelling, sulphate of iron and ammonia should be taken instead of protosulphate of iron.

CARE OF THE INTENSIFIER.

Watery pyrogallic solution oxidizes rapidly when exposed to the air; it should be prepared fresh every day. The solution of silver and citric acid will keep for more than a week. Citric acid appears, however, to be liable to decomposition, and is apt to cause bluish veils on the negative; an addition of 1 per cent. of fresh citric acid will remedy this.

CARE OF THE FIXING BATH.

The solution of cyanide of potassium, if used, should be prepared fresh every day.

Hyposulphite of soda solution will keep longer. Continued use and acids will cause decomposition. It should be prepared fresh every four or five days.

CARE OF THE VARNISH.

Varnish is subject to similar changes as the collodion. It becomes thick by evaporation of the alcohol, and dusty by the varnish which

is poured back from the plate into the bottle.* It is advisable to pour the excess of varnish from the negative into a separate bottle. It can be diluted with alcohol, filtered, and used like fresh varnish.

On the eating away of the collodion film, see page 129.

CARE OF THE FINISHED NEGATIVE

Will be explained in the chapter on the positive process.

SECTION III.

FAILURES IN THE NEGATIVE PROCESS.

The number of failures in the negative process is legion. The cause is on the one hand the changes and variations to which our apparatus and solutions are liable, and about failures occurring from this source we have spoken in the previous chapter, under the heading, "The Care of the Camera," etc.

Those who have carefully studied this chapter, and know how to apply what they have learned, will readily avoid many of the causes of ill-success. On the other hand, *want of attention* or *want of skill* of the operator is often the cause of trouble.

If we do not proceed with our labor with the *greatest conscientiousness*, we will always have to contend with failures. Some of them, as, for instance, wrong pose, faulty illumination, too long or too short an exposure, will happen to every beginner, and can only be overcome by long practice.

The failures in the negative process manifest themselves generally on developing the plate. *It is therefore imperative not to intensify or to finish until after the plate has been washed after being developed, the back carefully cleaned, and closely scrutinized for any apparent faults.*

1. VEILS OR FOG.

The main trouble is the fogging of the plate. This is a general precipitate of silver which covers the whole plate, light as well as shade. The causes are manifold. *a.* The so-called dark-room admits too strong light (the author works only with subdued lamplight); *b.* The plate has been exposed to too intense lamplight; *c.* The camera or the

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* It is well to dust the plate previous to varnishing with the camel-hair pencil, and loose pieces of collodion film at the edges of the plate should be removed.

plate-holder has holes (in the latter case the spots will always be opposite the opening); *d.* Bright light enters the objective (this happens frequently when the lens is placed opposite to an opening in the curtain or the bright sky); *e.* The collodion is alkaline (in this case a few drops of tincture of iodine will remedy the evil); *f.* The nitrate bath is alkaline (remedy, addition of acid); *g.* The nitrate bath contains organic substances (in this case the plate is generally very insensitive—remedy, permanganate of potash); *h.* The bath contains subnitrate of silver formed by nitrous acid. When this happens, the bath should be discarded, and used as a positive bath. Other causes are arranged according to their origin.

2. FAILURES DUE TO THE MODEL.

Yellow spots, scarcely visible to the naked eye, as freckles on the face, spots of iron-rust in the paper, manifest themselves in the photograph in a remarkable manner, and are sometimes ascribed to the chemicals.

3. FAILURES DUE TO CLEANING AND POLISHING THE PLATE

Manifest themselves partially by breathing on the plate. The plate takes the breath unevenly. Some, however, become visible only after development.

1. Precipitates of a silvery lustre, between the collodion film and the glass (best visible from the back), are caused by badly acidified plates, or with old plates which have frequently been used and carelessly treated. Remedy, immersion for twelve hours in chromate of potash solution. If this remedy fails, such plates may still be used, but should be albumenized (see page 116).

2. Mossy-looking designs, proceeding mostly from the lower corner. Cause, dirty plate-holder. Remedy, wash the plate-holder with warm water, wipe it dry, and coat with asphalt varnish. Coating with negative varnish will also remedy it, but it does not last long.

3. Dirt along the margin of the plate, or spots which extend more or less to the centre, are caused by insufficient cleaning *of the rough edges of the plate,* or by becoming soiled later by resting the plate on dirty substances (paper, table, plate-holder, etc.), or by handling them with dirty fingers.

4. Polishing streaks show very plainly, by being reproduced in the direction of the polishing motion. *Cracks in the glass* give frequent rise to streaks when the polishing powder settles into them.

5. *Bright* irregular spots and short lines are caused by dust or woody fibre falling on the plate when the plate-holder is opened.

6. Short, black, and crooked lines (rat-tails) are due to the use of impure albumen in albumenizing the plates.

4. FAILURES DUE TO THE COLLODION

Manifest themselves partly after silvering, partly after developing.

1. The plate leaves the bath with a *transparent insensitive margin.* This is due to the time between collodionizing and sensitizing being too long.

2. The film is rotten, and tears easily in the bath. Cause, the plate is placed too soon into the bath; the collodion is too old; the bath is too acid.

3. The film is of *uneven thickness.* Cause, the plate is coated unevenly.

4. Spots which proceed from the corner at which the plate has been held. The collodion should not touch the fingers.

5. Thick and thin and partly streaky spots are caused by air-bubbles which have broken when the coating was finished; also, in consequence of unequal drying, caused by the warmth of the fingers or the evaporization of collodion which has flowed on the back of the plate; also, in consequence of old pyroxylin, which dissolves badly.

6. Diagonal streaks. Cause, the plate has not been rocked properly while being coated.

7. Comet-like black spots. Cause, newly iodized and insufficiently settled collodion. *White and black worm and snake-like* lines occur also with new and insufficiently settled collodion, particularly when using salts which do not dissolve readily. They disappear when the collodion has settled or has been filtered.

8. Cross-like or tile-like drawings are easily formed in very cold weather, or when the collodion contains much water.

9. Black irregular spots. Cause, dirt in the mouth of the collodion bottle.

10. Collodion, which at first works excellently, gives after a short time faulty plates. Cause, impurities which get into the collodion by pouring the excess from the plates back into the bottle. Remedy, the excess should be collected into a separate bottle.

11. Want of sensitiveness is met with in old and very red collodion.

12. The film *adheres badly to the plate.* Cause, old and acid bath, or old pyroxylin.

13. The picture shows a honeycombed structure. Cause, the plain collodion was too tough. Remedy, the cotton is first dissolved in a mixture of three parts ether and one part alcohol, left to settle, and to the clear decanted collodion the balance of alcohol and ether is added.

14. Fog. Cause, the collodion is alkaline. Remedy, add tincture of iodine. Sometimes the collodion has been contaminated with organic substances, which will also produce fog, which cannot be removed by any remedy.

5. FAILURES DUE TO THE SILVER BATH.

1. White streaks in the direction of the dip, partly horizontal straight lines (with a bath), partly curved (with dishes), and round spots caused by air-bubbles. They are recognized after sensitizing. Cause, want of steadiness in immersing the plate (when using an upright bath); too little solution (when using a dish).

2. Black streaks in the direction of the dip (particularly with a bath, but also when sensitizing with dishes, the film being downward). Cause, the plate has not been placed long enough in the bath, or the bath is too old and contaminated with organic substances.

3. Black streaks originating from the dipper. Cause, dirty rubber dipper.

4. The film is eaten away. Cause, the bath contains too little or no iodide of silver.

5. Pale and transparent plates, but little sensitive, are produced sometimes by great heat. Remedy, cool the bath by placing it in ice-water, or by wrapping wet cloths around it and placing it in a draft.

6. Spears, crosses, and swords. Cause, the bath contains sulphate or acetate of silver. Remedy, filtering through clean filtering-paper.

7. The plates appear as if dusted over with flour. Cause, large precipitate of iodide of silver caused by heat. Remedy, filtration and reduction of temperature.

8. Small holes (pinholes). Cause, excess of iodide of silver. Remedy, cooling the bath, or dilution with thrice its volume of water, filtering, and evaporating.

9. Black spots, caused by pressure on the collodion film, are frequently due to slight elevations on the sides of the bath or the bottom of the dish.

10. Insensitiveness is caused by great acidity of the bath, also by organic substances. Remedy, neutralizing or treatment with permanganate of potash.

11. Gray and grizzly spots are caused by imperfect immersing.

12. Fog is caused by an alkaline bath or by organic substances.

13. Weak pictures are often due to old and frequently "doctored" baths.

14. The plates look blue instead of yellow. Cause, there is too little iodide of silver in the bath. Remedy, solution of iodide of potassium in this proportion: for every 1000 cubic centimetres of bath solution, take 25 cubic centimetres of solution of iodide of potassium, of the strength of 1 to 100.

6. FAILURES DUE TO EXPOSURE.

1. Want of sharpness or double outlines. Cause, careless focussing, shaking of the camera or the objective during exposure.

2. Marbled spots and drying spots are caused by too long exposure with a fresh bath, and in warm weather.

3. Hard pictures—too short an exposure. Weak pictures are sometimes caused by excessive illumination (see also section 5, No. 13).

4. The picture is of unequal intensity. Cause, unequal illumination, particularly with drawings (see also section 8).

5. Foggy spots with drawings and oil-paintings are caused by reflected light. Remedy, change the illumination.

6. Fog is caused by side-light, or sometimes when the bright sky or the sun shines into the objective.

7. Double pictures are due to fine holes in the board carrying the objective.

8. Stereos of unequal light (also single pictures) are caused by objectives of unequal light intensity, or by a plate which has been coated unequally. The thick spots are more sensitive than the thin ones.

7. FAILURES DUE TO DEVELOPMENT.

1. Bright halo at the place where the developer has been poured on. Cause, the developer has been poured on too violently (see the chapter on Development and the Developer).

2. Black crooked lines, developing streaks. Cause, the developer has not been flowed on evenly.

3. The film repels the developer. In this case the developer contains either too much alcohol (for instance, with a new bath), or too little (with an old bath); it should be harmonized either with alcohol or a watery solution of sulphate of iron.

4. A dark margin to bright objects at the place where the devel-

oper has been poured on, and which appears in the positive as a bright halo, is a very common occurrence in developing; it is due to an accumulation of precipitated nitrate of silver at the spots where the developer accumulates. By changing the direction of the current they can be partially avoided.

5. Fog is sometimes caused by a too strong, too *hot*, or by a developer containing too little acid.

6. Most of the abovementioned phenomena usually manifest themselves during development, although they are not actually faults of development.

8. FAILURES IN INTENSIFYING.

1. The intensifying solution is repelled and causes spots (particularly when intensifying with salts of iron); alcohol is wanted.

2. Pale spots are due to the same cause, when the developer, no matter which one, does not flow evenly over the whole plate.

3. A gray and grainy precipitate is formed when we allow the iron developer to act until it becomes turbid.

4. Bluish precipitates in the shadows are formed through want of acidity, or when an old pyrogallic solution is used.

5. Thick spots are formed by pouring the developer always on the same spot, particularly when the intensification is long continued.

9. FAILURES IN FIXING.

1. The plate looks greenish or bluish when plates containing salts of iron are fixed with cyanide of potassium and have not been washed thoroughly before fixing.

2. Black streaks, generally only visible when looking on the plate from above. Cause, too cold a fixing solution, or a too weak one, or the time of contact has been too short.

3. Transparent spots are formed by a too strong solution of cyanide of potassium which eats the film away.

10. FAILURE WHICH MANIFESTS ITSELF ON DRYING THE PLATE.

The film appears iridescent and tears; this happens with long intensified and short-exposed plates. They may be saved by varnishing them when still damp, by drying them, and applying a second coat of varnish warm. It is still better to apply to the damp film alcohol of the strength of 60° and to varnish afterwards.

11. FAILURE IN VARNISHING.

1. The film dissolves, the picture is washed away. Cause, the alcohol in the varnish is too strong. Add 1 per cent. of water (see the chapter on the Varnish).

2. The film looks dull. Cause, the plate was too cold or the varnish too thin.

3. A streaky film is formed when the plate was too hot, or if the rocking motion of the plate when applying the varnish has been uneven, or when the varnish has been too thick. In the latter case dilute with alcohol.

NEGATIVE RETOUCHING.

SECTION I.

PRACTICAL PART.

THE picture which has been obtained by the negative process is by no means a true representation of the object (see the chapter "Photography and Truth"). The contour and lines are nearly true if they are in the picture at all, but it is different with light and shade, as will easily be seen by taking a positive from the negative. Sometimes the result is very good, but very often the bright lines are too bright; the shadows too dark; the slit of the mouth, the sockets of the eye, which naturally look at most gray, appear in the picture black; partly this is due to underexposure, partly to the insensitiveness for feeble light.

Add to this the faulty action of the colors: yellowish skin, red hair, affect the plate like negro heads; yellow spots (freckles), barely visible to the naked eye, look in the picture strikingly dark. These discrepancies have to be removed; formerly this was done by retouching the positive, now the negative is retouched, by making the spots which are too transparent more opaque, either with color or with lead-pencil, which is applied until the transparent spots and the surrounding are of the same tone.

It is obvious that certain transparent parts like wrinkles may be removed entirely, but this is not the purpose but rather a misuse of the retouch.

We will show further on what may be retouched and what should not, and we will begin with the technical parts according to Grasshoff's excellent instructions.

In order to facilitate the working of the negative plates it is well to provide a stand with a mirror; such can be bought at the stock-dealers. The stand is placed near the window in such a manner that the mirror reflects the sky, the support carrying the negative is placed obliquely, the latter is screwed firm, and the negative may easily and without fatigue be examined. Care should be taken that the sitter and the plate are as much as possible in the dark. Those who are compelled to work in the atelier, or in a room in which there are several windows, should take care that no light strikes the plate from above, otherwise too little of the work to be done is visible, therefore the head and the stand should be covered in such a manner that the operator sits entirely in the dark.

Lately stands of this kind can be bought ready made, but an arrangement may easily be made with pasteboard.

If the retouch has to be made at night, the mirror with reflected lamplight *cannot* be used; it is advisable to employ a lamp with a shade of ground-glass, and to place it so low that the subdued lamplight strikes the plate from below and passes through it. Besides, several pieces of dark paper, according to the size of the plate, should be handy, with oval or round openings of various sizes, for covering the negative in such a manner that only the head remains visible.

By such an arrangement the eye is less dazzled, as otherwise the transparent dress, etc., transmit much more light, which disturbs the worker. The varnish is also protected, particularly when the same is new.

One of the most difficult negative retouches is a large portrait-plate, and it is particularly the head which requires all the attention, and I therefore write in this sense.

It has been proposed to coat the negatives with gum arabic after fixing, and to retouch them afterwards, and to varnish the retouch. In experienced hands the results are very good, but it happens frequently that in varnishing the varnish penetrates but partially the thin film of gum, and the negative is easily lost by becoming spotted. The operator has also to proceed with the greatest caution in working on such a gum film, as the point of the pencil easily penetrates the collodion, and makes holes. For all these reasons, retouching on the varnish is preferable.

The same applies to the method of coating the negative with glue or gelatin, to retouch on this, and to varnish afterwards.

A negative varnish containing much shellac does not take lead-pencil retouches (of which we speak here principally) very readily. I recommend, therefore, the following, which is really excellent. The same may also be used to advantage for positives.

Take—

15 parts absolute alcohol, and dissolve therein
$2\frac{1}{2}$ parts pulverized sandarac,
$\frac{1}{2}$ part camphor, crumbled,
1 part Venetian turpentine,
$\frac{3}{4}$ part oil of lavender.

For use, the varnish is more or less diluted with alcohol, to which, for every ten or twelve parts, about one part of distilled water is added, or also some spirits of wine, as sold in the distilleries.

It is preferable to dissolve the resins in pure alcohol, as it goes quicker, and is more reliable.

The addition of water to the alcohol, or in its place the use of spirits of wine, is recommended, in order that the varnish may not destroy the transparent shadows in the negative.

The hardness of the varnish on the negative increases with age, and the hardness of the lead-pencil should be regulated accordingly. With a very soft varnish a soft lead-pencil should be used, and the hardness should be increased with the hardness of the varnish. Grasshoff used pencils of A. W. Faber, and gave the preference to those of Siberian plumbago, Nos. 1 to 4, because they are extremely fine, and actually free from hard substances. Shortly after varnishing he employed Nos. 1 and 2; after a few hours No. 2; the next day, and after the varnish has become still dryer, Nos. 3 and 4 only should be used.

The very smooth and dry varnish does not always take the lead-pencil lines readily. Grasshoff recommends, therefore, cuttle-fish bone. The same should be scraped very finely, and rubbed with the finger very carefully over the negatives, particularly on the spots which are to be retouched—for instance, the face, or rather the head—and until a dull surface has been obtained. The plate now takes lead-pencil or India ink readily, and we are able now to lay on excellent transitions from light to shade.

The varnish film should not be too thin, but rather have a fine and strong surface, and the more this is the case the less will it be possible to get small, hair-like cracks, by rubbing it with cuttle-fish bone. In place of cuttle-fish bone, we may also use finely-powdered pumice-stone.

The inequalities of the negative—for instance, freckles and other

spots which show too dark—should be worked with lead-pencil in such a way that they can no longer be distinguished from the surrounding parts; so, also, large parts of the shadows will have to be worked over, and particularly the sudden transitions from light to shade, which we often notice in the negative, will have to be equalized, in order to make the whole negative more harmonious.

The lead-pencil work, however, does not suffice always, as its covering capacity is but limited, particularly on very transparent parts over the eyes, with much top-light illumination. Other parts which print too darkly, and which would give to the picture too heavy and too deep a shadow, have to be relieved, and here the best remedy is gum arabic and india-ink, which has been mixed with water. The mixture should have a syrup-like consistence, and the color should have double the brilliancy, than if mixed with water only, and put upon paper. It is also well to add to the gum solution a few drops of glycerin—to half an ounce, about four or five drops. The color works better, and does not rest so brittle on the varnish. By varying the quantity of the gum, the covering quality of the color may be pretty well controlled. If it does not cover sufficiently, the too transparent spots may be looked after for a second or third time, and they may be painted, or rather stippled over, until sufficient density has been obtained. It is only necessary to let the color become dry, before a second coat is laid on, and but little paint should be taken on the brush.

With these gum colors, whole parts of the picture which appear too transparent may be covered so as to secure an even tone—for instance, the hands or arms, light dresses, or hair which has not been powdered; also, blonde beards, which would print too darkly; parts of uniforms or costumes, if not too large. With a large and full brush such parts are uniformly covered as evenly as possible, without regard to the outlines, in order that the color may remain liquid. We breathe on the plate, and distribute the color as evenly as possible. This requires practice, but after a few trials it will not be difficult to produce an even plate. When the color has become dry, those portions of it which overlay the outlines are removed. This is done with a damp brush.

In many cases it is advisable to apply this kind of retouch to the back of the negative.

Spots, and the like, which still appear in such retouched negatives, are either removed with lead-pencil or with color.

On the back of the negative, *i. e.*, on the glass, some parts are thinly covered with color, in order to insure a lighter and hence more

correct printing of objects which appear too dark in the picture. It is in this case, owing to the thickness of the glass, not so necessary to observe closely the outlines of the picture. The ordinary india-ink, without the addition of gum arabic, may be used also with advantage, as it covers better.

After the color has been laid on, we breathe upon the plate, and touch it with the point of the finger, until a uniform grain has been secured, for on the back of the picture an exceedingly even distribution of the color is not necessary. If the density of the color is insufficient, and it is desired to lay it on a little heavier, or only in some places a little denser color is required, this may easily be done with a soft lead-pencil, with which shading or stippling may be laid on.

Sap red, sap blue, Prussian blue, burnt terra, sienna, and gamboge, for covering or partially covering, are also frequently employed, because those colors, owing to their transparency, are well suited for it, but with these colors it is much more difficult to judge of the density than with black, and by adding gum arabic, the even laying on of the colors is made easy, which otherwise is more difficult than the laying on of the blue, red, or yellow. Practice has much to do with success, and an experienced hand secures good results with any color, if it is understood how to keep the right tone.

The small holes, dots, or other spots in the negative are best covered with ordinary india-ink, without the addition of gum arabic, but wetting the point of the brush with the mouth should be avoided, as this will prevent the color from adhering and covering.

The negative retouch after oil painting still needs mentioning; negatives of this kind are very difficult to retouch. The different sensitiveness of the film for color, produces sometimes the most glaring contrasts in the negative, and it is often of advantage to cover the whole plate with a thin color, to which a solution of gum arabic has been added, either on the side that has been varnished, or also with large plates on the back or glass side. The color is poured on the plate, and flowed over it very evenly and left to dry. On the places where the color is too heavy, it is removed with a damp cloth or a moist brush, etc. The aniline colors of Dr. Jacobsen are well suited for this purpose; they are to be had at the stockdealers. Owing to their fineness of grain, they furnish the desired even coat of color. Particularly suited are green, yellowish-brown, and reddish-brown. A quantity of gum-arabic solution, not too thick, is taken and colored with the desired tint (in a wide-mouthed bottle), and poured on the negative, left to dry in a place free from dust, and when dry, the removal of the places which are too dense is commenced if necessary.

It is impossible to describe this accurately, but practice will eventually secure success.

It may also happen that the coating with color does not give good results, if a great many copies have to be made, and all water colors are not insensitive to light and air. In this case another method is preferable (particularly with large surfaces and landscapes taken from nature), and that is, to take the finest oil-paper, coat it evenly with starch, and paste it to the glass side of the negative; after it has dried, those places which print correctly should be cut out or scraped out.

More delicate transitions should be made with lead-pencil. This is done to particular advantage with those parts of the negative taken from an oil painting, in which the lines, ridges, and depressions of the paint have thrown shadows, which in the original are not noticed.

Finally, some remarks on landscape photography. Not always is sky, or rather the air, so pure and clear and opaque in the negative as is desirable, and in this case it is necessary to remedy it with the brush. If the sky is clear and bright, and disturbs only because it produces a monotonous surface, which frequently happens, it is advisable to paint a few clouds on to it. This is done most easily, especially when we are not very particular about the shape, with india-ink, to which considerable gum arabic has been added. The clouds are painted on the glass side of the negative (this need not to be done very finely). By crossing and laying the color on several times, the lesser or greater density will be reached, and by lead-pencil drawing the brighter parts will be produced. Excellent for this purpose is black oil paint, to which a little siccative has been added. This color admits of very even distribution, and as it remains moist for a long time, even difficult cloud effects may be made with it; as a pattern, a cloud negative from nature serves very well. To print the clouds into a negative by using two negatives does not always give satisfactory results, as frequently such cloud effects do not harmonize with the landscape, and hence disturb. A change in the drawing is easily made. Although the thickness of the glass will give to the outlines already a rather washed appearance, still it is well for the beginner to shade off. Such a negative can of course only be used after the oil paint has become dry.

Sap red or blue is often used for painting cloud effects; I, however, as stated before, give the preference to black.

When it becomes necessary to back out the sky entirely, so as to make the same appear as a perfectly white surface, red is preferable, for instance, vermilion, English red or Vandyke red, and the like. One of these dry colors (black will also do) is rubbed very finely on a

glass plate, with a glass muller, and water, and to the thick color a little gum arabic and a few drops of glycerin are added. The color is now rubbed for a second time, and the whole syrupy mass is preserved in a suitable vessel for future use. The addition of gum arabic should be but trifling; the color should, when placed on paper or glass, not rub off. The addition of glycerin is to prevent the splitting and cracking of the colors.

The red color is preferable because it covers well, is easily seen, and the outlines can readily be corrected, and even if a spot should not be sufficiently covered, the thin red color permits less light to penetrate than a thin black color. Particularly the Vandyke red is good for this purpose, and for stopping up small holes in the negative.

A plain ordinary color mixed only with water is in most cases sufficient to back out the sky; it is advisable to add to such a color a few drops of glycerin.

I will still mention that in place of the gum solution, the following mixture may be used: A small quantity of the yelk of an egg is mixed with about one-third of its volume of oil, and thoroughly stirred in a glass; a little water is added, and this compound is used in place of gum arabic and glycerin. Linseed oil, poppy oil, and sweet oil, are suitable for this purpose, but linseed oil is the best. This compound may be laid on in a great many layers without dissolving the underlying stratum, provided that the latter has become sufficiently dry. In water it does not dissolve readily, it should therefore be kept moist.

The finishing of the outlines has to be done very carefully when on the varnished side; the balance of the picture is pasted over with red paper, cut of suitable size.

As the retouch frequently suffers when handled too much, it is advisable to protect it in the following manner: Take common amber varnish (the fine amber varnish dries very slowly owing to the large proportion of oil it contains), dilute it with 8–10 parts of oil of turpentine, filter well, and coat the negative with it in the ordinary manner. Let the negative dry in a place free from dust. On the next day, or later, the plate is very carefully retouched with a soft lead-pencil; color may be laid on in any suitable way, as well with oil as with water colors, and when the whole of the retouch has been finished, the plate is warmed a little, and coated in the ordinary manner with an alcohol negative varnish, and the latter is dried with moderate heat.

Under certain circumstances a retouch may be made on this surface also.

SECTION II.

THE ÆSTHETICAL PRINCIPLES OF THE NEGATIVE RETOUCH.

We have already remarked above, that by no means everything which appears in the negative as transparent should be covered by the retouch, and we will now cite Hartman's principle, which should be gospel to every retoucher.

In contemplating the human head and the formation of the face, we observe that those parts where the underlying rigid, bony structure is most prominent are subject to the least variation. The surfaces of the forehead, the root of the nose, the jaws, the margin of the sockets of the eye, always maintain their relation to each other.

They determine the likeness in conjunction with the position of the slit of the eye and the mouth, with form and direction of the nose, and the most prominent parts of the chin. More or less contraction of the muscles, particularly of the closing muscles at the angles of the eyes and mouth, give the expression.

With both of these positions of the face, which are the controlling elements in giving it its form, the helping hand of the retoucher has to proceed with the utmost care. With regard to the third part, the skin, which partly gives roundness to the different forms, we can proceed with much more freedom, particularly where the hair, accumulated fat and flabby parts, and wrinkles present themselves. We must not forget that the skin, which forms everywhere the surface, in consequence of spots and impurities, very often exercises a greater chemical action than the lower forms, which are generally distinguished by a delicate variation of light and shade.

To give due prominence to the latter, and to reproduce solely the variations of light and shade, to exclude the disturbing element of color, is the main purpose and the main difficulty in retouching. Let us try to demonstrate these principles in detail, and to get them understood. Let us follow the relation of the different parts of the face, its changes in old age, its differences in the sexes, its value for expression and likeness.

The forehead, very round and soft in the child, becomes expressive in the man, and divided into distinct surfaces, and forms a prominent feature of the character. The upper part of the forehead shows the forms of the skull the best, and with the least variation; only the lower part of the forehead, just above the eyebrows, is enriched with a very movable set of muscles.

With suitable illumination the surfaces of the upper forehead become distinctly separated, and the care of the artist should be directed to clearly define the boundaries of these surfaces, and to make them appear as a harmonious whole. A forehead which is too round is admissible in the female, but in man it looks too feminine, and lacks beauty here more than anywhere else. The defining of surfaces is in order.

The wrinkles on the forehead are regulated by the attachment of the skin to the lower part of the forehead. They form horizontal grooves which run parallel to the ridges of the sockets of the eye, and finally disappear at the sides.

As they make their appearance in middle-aged persons, and as they follow the forms of the forehead, we may let them remain, and only need to soften them. The vertical cross-wrinkles, which make their appearance in advanced age, make an unpleasant impression, and should be removed entirely. Only the two main vertical wrinkles, which proceed from the root of the nose, and which divert the horizontal wrinkles, should remain.

The margin of the hair at the temple is very soft, and a great attraction for the painter. The eyebrows, which vary greatly in thickness, color, and form, have, by following the lines of the sockets of the eye, the æsthetic value of being their limit. It is well to remove the hair which grows too strongly upwards, and to preserve the arched form of the brow. A meeting of the brow above the nose is considered ugly. It gives to the face a sinister expression, particularly as in this place there is a shadow already.

The sum of the labor of the retoucher could hence be expressed as follows: Definition of surfaces; a consecutive separation and treatment of hard and soft hair margins; subduing or removal of vertical wrinkles, and a modified preservation of the large horizontal wrinkles; defining the arch of the eyebrow. How far these operations can be carried depends of course on the age and sex of the original.

The head seen in profile very often shows a want of expression in the back part. Smallness of the back of the skull in contradistinction to enlarged development of the frontal parts, imparts the characteristics of an animal. The deficiency should be supplied by retouching, and the head will gain in importance. Also, where the hair has been arranged in an unsymmetrical manner, we can easily reach the necessary balance by adding here a piece or deducting something at another part. Blonde hair, which generally takes too dark, can be heightened by laying color over it, while in the more exposed shady

parts of dark hair, the *necessary* harmony can be produced by drawing the *necessary* details.

Beards and whiskers should be treated in a similar manner.

The Nose.—What we have said of the bony structures of the forehead refers also to the upper part of the nose, the lower part consisting of a firm muscle which offers more or less surface. The ridge of the nose should be clearly defined, and when necessary a *high* light should be placed on it, to separate it from the side surfaces. The shadows of the nostrils must be covered, and the sides can be reduced where they are too prominent on account of size. Crooked or oblique noses in the front view, very often admit of improvement. The shadow in the nostrils must not remain absolutely black. Attention should also be given that the heavy shadow under the nose is not of the same depth with the side shadow; by lighting the point of the nose a little it dissolves itself at once, and becomes more plastic.

In a profile view, it is not admissible to alter anything in the characteristic form of the ridge of the nose. The fleshy part, on the contrary, which, with advancing years, sometimes becomes unusually large, can be reduced in size without any material detriment to the likeness.

The Mouth in its mobility, in the depression or elevation of its corners in its larger or lesser expansion, is a main indicator of mental processes; particularly with children, skilful retouching can retrieve what was lost in the taking of the picture. To begin with, the lips should be separated from the slit proper; also the angles should be closely defined; next the ugly cracks of the lips should be entirely obliterated. The form of the mouth can be materially improved by clearly defining its margins. When, with advancing years, the lines of the mouth become lost in the wrinkles of the corners, it is well to modify them, at least they should not be left as sharply defined as the lips. Above the mouth also, depressions and wrinkles show themselves particularly in elderly persons, thus easily giving the impression of an unshaved beard. They should be removed. But attention should be given to the different values of light and shade of the parts which are located between the mouth and the nose, particularly the elevated portion extending from the dividing line of the nose to the upper lip. The sharp definitions of the outer lines of the lips is very variable in different individuals. Soft thick lips receive more light than those of normal form. In the former case the outlines should not be too clearly defined, as this would give prominence to a form, which is not warranted by its light effect. The angles of the mouth may be modified, and in the heads of elderly persons, reduced in size,

but should never be entirely obliterated; this modification can be made stronger in the lower than in the upper lip, for when the corners of the mouth are drooping, they indicate weakness, sorrow, or other unfavorable expressions.

Teeth, generally, are much shaded; to obliterate them completely by removing the opening between the lips is sometimes desirable, except where the opening is considerable, when the lips would become too large.

The eye is of so much importance as one of the most prominent parts of the face that already, during the sitting, the principal attention of the photographer is given to its direction, its expression and its surroundings. Notwithstanding all this there is plenty left for the helping hand of the retoucher. I will mention a few instances. The clear and steady expression at the beginning of the sitting becomes disturbed, the lids and eyeballs sink almost imperceptibly, and the high-lights in the upper part of the latter become indistinct, or are entirely covered by the lashes. It is easy to improve here; the edges of the iris should be sharply circumscribed in the negative, and the high-lights should be covered. It frequently happens that the high-lights in the eye, on the shady side of the picture, are stronger than those of the illuminated side; it is self-evident that a medium effect must be produced here. In a similar manner the lower lids frequently lack sharpness on account of the repeated shutting of the eyes. On the edge of the lids we generally find a sharply defined and very prominent light, generally brighter than the tone of the white in the eye; this light is easily defined and intensified. Through the white of the eye we frequently find, and this is particularly the case with aged persons, numerous small arteries intersecting it, which in the photograph give a motley and spotted appearance. These can be removed entirely, only attention should be given that the white does not become too bright.

Regarding the surroundings of the eye, the fleshy part above it is apt to appear too dark, and become unpleasant. The aim should be to lighten them and the eyebrows, also the wrinkles above the eye, and the photographic gradation of tone should be made to correspond as nearly as possible with the natural ones. The so-called tear-bags under the eye generally throw a shade which looks too dark in the picture. The wrinkles, which in aged persons almost invariably make their appearance here, may, in a modified form, and in their horizontal direction, be maintained, only the lines running crossways, which always give an irritating effect, should be obliterated; this gives clearness to the lines which run parallel with the lower margin of the eye,

and which in their inner end point towards the angle of the eye. Immediately adjoining the lower of these lines is the flesh of the upper cheek, which firmly rests on the bone ridge which forms the socket of the eye, and which in its almost invariably recurring arched form, should be preserved, collecting the light on it. A shadow extending under the eye downwards is either a consequence of a darker color, or of a deficiency in flesh, which gives to the face a neglected and sorrowful aspect. When this is not very prominent it can be removed entirely, otherwise it can be modified to a considerable degree. The wrinkles in the corners of the eyes, the so-called crow feet, are too characteristic and should not be obliterated entirely.

The Cheeks are, in their outlines and surfaces, determined by the prominence of the cheek-bones. A certain view will bury the cheekbone in its profile, and will give it too much prominence. This want of beauty, which is peculiar to the Mongolian race, is easily remedied by cutting off the too prominent curve of the bone. As to the surface formation of the cheeks care should be taken for a gentle, but at the same time determined, separation of the front and side parts, to avoid the shadows which indicate excessive thinness. Where exposure to the weather has darkened the cheeks, as is the case with soldiers, or people who lead an outdoor life, the surfaces should be covered on the back of the negative.

The Chin is, in old and fleshy persons, generally provided with a cushion of fat, which extending downwards covers a large portion of the throat in a manner by no means beautiful, and by giving too much breadth to the lower part of the face causes ugly proportions of the head. As we have already remarked above, collections of fat, being merely external, are the parts of the face most accessible to retouch.

In profile views parts can be cut off. In full face views, by removing the lower folds, a part of the so-called double chin can be united with the throat, and the side has to be changed correspondingly.

The dimple in the centre of the chin has to be modified, as it often takes the form of a cut, or a dark tint.

The Neck.—What we have said above in regard to the chin, refers almost with equal force to the neck. Where the neck is thin, the artist will do well to cover the shadows which are produced by veins, arteries, sinews, etc., and by corresponding additions or diminutions to bring about a form. The same may be said of the *shoulders*, the *bosom*, the *arms*, *waist*, and *hands*. Of course we can proceed here with more freedom, as the parts mentioned have not the same value in producing the likeness as the different parts of the face. Angular

and thin shoulders, thin arms, a deficient bosom, and all the shoals threatening female beauty, the painter should avoid under all circumstances, and the photographer may do likewise whenever his taste and his knowledge of the normal form permit him to do so. This refers also to crooked outlines of the hair, to the removal of folds in ladies' ill-fitting dresses, as they appear so often in the sleeves, or on the shoulders; likewise in the pantaloons of gentlemen.

It is certainly a circumstance in favor of retouch, and particularly of the negative retouch, that by skilful manipulation a number of shortcomings may be avoided, which by arrangement, position of the original, and all kinds of experiments, can only partially be overcome, and which would give the parties concerned a great deal of trouble.

CHAPTER V.

THE POSITIVE OR SILVER PRINTING PROCESS.

The pictures which are taken with the camera obscura are on glass; when we look at them by holding them to the light they appear negative, while by reflected light and with a dark background they appear positive.

The silver which covers the high lights appears by reflected light grayish-white or bright, while the uncovered transparent shadows show the dark background and appear dark, hence the whole picture appears positive.

On account of the heavy deposit of silver on our negatives the finer details are not visible in the lights. When, however, the exposure has been short, and no intensification has been resorted to, we will get a picture with good details, which in America is called an "ambrotype."

These ambrotypes were much in vogue in the early days of the collodion process. The gray color, however, the reversion of right and left, and their liability to become broken, brought them soon into disfavor, and the public gave the preference to paper pictures, which are made by placing a sensitive paper under a negative and exposing it to light.

The operations necessary for this purpose are called the printing or positive process.

There are two kinds of printing processes:

1. The direct printing process, where the exposure to light is continued until the print has reached the desired intensity.

2. *The indirect printing process*, or printing by development, where the paper is illuminated for only a short time, and the picture is afterwards brought up to the necessary intensity by development. This latter process is analogous to making a negative, and can also be employed in making transparent positives on glass.

The direct printing process is the one which is generally practiced.

From drawings, direct copies can be taken by the aid of the aniline process. Pictures can be made in gold, silver, and pigments; the negative can be reproduced on stone and metal, and prints can be taken from the latter.

Generally, we understand, when speaking of a photographic printing process, a method of producing a picture by the direct action of light on a sensitive piece of paper. I may mention also the production of silver, iron, or uranium pictures, and the pigment or carbon pictures.

Of all the different printing processes only one has firmly taken hold in practice; it is the silver printing process, or the production of a picture on paper which has been treated with a solution of the salts of silver.

Of all the different processes it is the easiest to manage, yields with the simplest means the most brilliant effects, and would be perfect if the results were permanent, or if the gases containing sulphur would not affect the silver prints in a similar manner in which these gases affect metallic silver, by turning it into a sulphate, which makes them look yellow.

Lately the carbon printing process, on account of the permanence of its results, has been employed for the production of pictures where permanence is the main object.

If a sensitive paper which is darkened by light is covered with a negative, the light passes through all the transparent parts of the negative and blackens the paper, but under the dense parts of the negative the paper remains white. The result is a picture which is the contrary of the negative, *i. e.*, a positive "print." To get a sharp picture in this manner, the paper must be in intimate contact with the negative; both are pressed together.

The machinery which is necessary for that purpose is of a very simple character.

The negative is ready; it is necessary to bring the same in close contact with the sensitive paper, and to expose it to light. The light passes through the negative from all sides; a print can only reproduce itself as a print, when the distance between the paper and the negative film is equal to 0. When the distance is greater the print will appear as a diffused circle of light. The picture will not be sharp. To secure this intimate contact, presses called printing-frames, are used, and this has given to the process the general name of printing process.

The printing-frames consist of a wooden square *a a*, in which a piece of plate-glass has been inserted, and a cover *D*, which is divided in the centre and supplied with hinges. This cover is pressed against the negatives by the springs attached to the crossbars, *e e* (see Figs. 67 and 68), or *f f* in the frame for large prints, Fig. 69.

The negative is first placed into the frame with the film upwards; on this the sensitive paper is placed; a piece of felt or a paper cush-

Fig. 67.

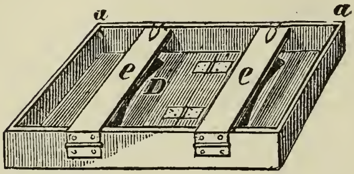
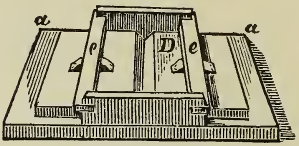
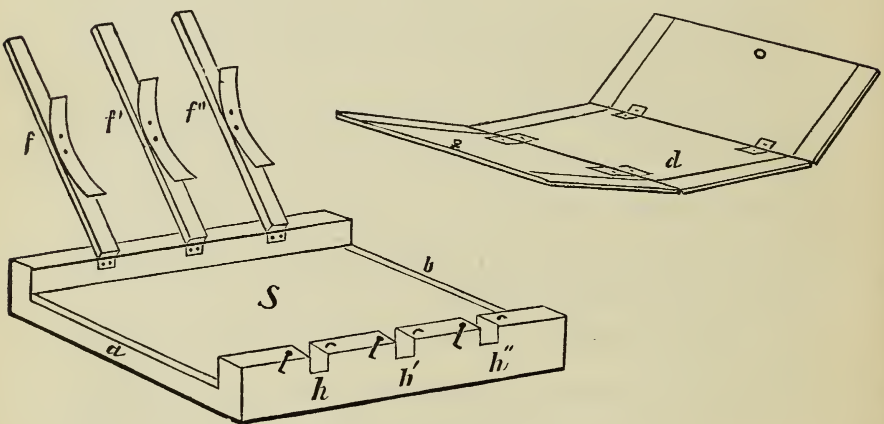


Fig. 68.



ion is laid on top of it; next comes the cover, *D;* and the whole is held in place by the springs and crossbars, *e e.*

Fig. 69.



In place of the springs, wedges are sometimes used; these are less liable to breakage.

For small plates, such as carte de visite negatives, the plate-glass can be dispensed with. This is of advantage, for it will always absorb some light. Meagher, in England, has constructed printing-frames in which the negative rests on bands of india-rubber. This prevents the breakage of negatives which are slightly curved,—a circumstance that frequently takes place when the negative is placed on plate-glass.

SECTION I.

PREPARATIONS.

I. *The Paper.*

In the negative process the collodion is the most important carrier of the picture; in the positive process it is the paper, of which we will give a description after noticing all the material necessary to its production. The sketcher uses for his designs a firm, smooth, homogeneous paper; this is also necessary in photography. On Swedish filtering-paper, for instance, we would obtain rough and fibrous pictures; besides this, the paper being soft and hard in spots, an uneven absorption of the sensitizing solution would cause an uneven darkening when exposed to the light. Further, the chemicals would sink into a porous or fibrous paper correspondingly, a part of the picture would be formed in the paper and be visible by transmitted light (like a negative) instead of reflected light. Besides this, such a paper would be very insensitive, and would be apt to tear in the washing. From the above intimations, it can already be seen what qualities a photographic paper must possess.

1. It must form a perfectly smooth, firm, and homogeneous stratum.
2. It must not allow the sinking in of the chemicals, but keep them fast on the surface.
3. It must color quickly and even, when exposed to the light, at the same time assuming a brilliant and pleasing tone.

The first requirement is met with a careful selection of the raw material. Only the best linen rags should be used. In the manufacture all iron utensils should be avoided if possible; they are the cause of rust-spots, which show black iron spots in printing. There are very few paper factories in existence which furnish a sterling paper for photographic purposes. There are really only two known, one in Rive near Paris, the other Steinbach's in Malmedy. These furnish almost all the enormous quantity which is daily used in photography. As remarked above, the paper furnished by these is the so-called raw paper, which must receive a supplementary sizing and salting to make it serviceable for photographic purposes. By this sizing the second requirement is fulfilled (see above). The sizing forms a protective covering, fills the pores of the paper, makes a homogeneous surface, increases the firmness and sensitiveness. The raw

paper is not, however, unsized, but has already received a sizing in the factory, either of gelatin and alum, or alum and resin soap. This sizing is generally a secret of the manufacturer, in consequence of which certain papers have gained a good reputation. The method of the sizing has an influence on the tone of the finished picture, therefore, little differences in the sizing have great effects in the appearance of the picture. The first sizing which the paper receives in the factory will suit for pictures of subordinate quality, but to obtain brilliant copies, the paper is covered with different substances, which besides requirement 2 (see above) fill requirement 3. For such purposes albumen, starch, and resin, seldom gelatin, and lately collodion have been used. Of the above substances, the first is mostly used. The albumen covering commends itself by its great sensitiveness to light, the intense, brilliant appearance it assumes in printing, pretty tone and gloss, and great sharpness of detail of pictures printed on it. It is, however, hard to retouch upon. The second substance is starch, which forms a covering of dim lustre, and produces inferior pictures of a dull tone, which, however, are easily retouched. The resin is seldom used, the quality being similar to the starch. According to these coverings the photographic paper is divided into albumen, arrowroot, and resin paper. The first is used the most, the second is only used for large colored or retouched pictures, the third has as yet received no common application. To prepare the first, the white of chicken-eggs is used, which represents more or less pure albumen and fibrin solution. The simplest process to make albumen paper is as follows: Separate the yolks from the whites; to 8 parts of the whites, 2 parts of a solution of 10 parts of chloride of ammonium in 100 parts of water, beat it to froth (or shake it), leave stand a few hours. The fibrin contained in the white is separated, which would make bronze-looking stripes. Pour the beaten and settled albumen in a flat dish, lay the raw paper with the sized side upon it, let it remain one and a half minutes, pick it up carefully, leave drain, then dry. Should any bubbles appear the operation must be repeated.

Hardwich recommends the following proportions: 15 ounces white of egg, 5 ounces water, 200 grains chloride of ammonium. One sheet of paper will take up from this bath, according to Hardwich, 6 drachms of albumen and 7 grains of salt. Lately, the quantity of salt added has been reduced 1–1½ parts, to 100 parts of albumen solution, the weak salted papers printing better under thin negatives. The water acts an important part in connection with the albumen, thick albumen producing a glossy surface and brilliant prints, therefore the thickly albumenized paper is called brilliant albumen paper.

The main difficulty consists in avoiding streaks, which would appear bronzed afterwards. To prevent this, the paper is laid on with a continued proportionate movement. Many papers are moistened very slowly by albumen; this is caused by greasiness; then add (according to Hardwich) 2 parts of spirits of wine (thinned) to 32 parts of albumen, or a few drops of a solution of oxgall in alcohol. The paper must not be moistened on the back, and not float too long, or the albumen will sink in (by dissolving the sizing), and produce weak pictures. The more water is added to the albumen, the duller is the appearance of the paper prepared; in this case, however, the sizing of the raw paper has a great influence thereon. After removing from the dish, the sheet is hung up with two pins, the surplus albumen is allowed to run off, then place the sheet in a warm place, previously fastening all corners. Finally press the sheets and keep them in a middling cool place.

To prepare the arrowroot paper, take 100 water, and 2 to 3 NaCl; heat the filtered solution to the boiling-point; add $3\frac{1}{2}$ parts of powdered arrowroot; stir constantly; pour through a towel; spread the mixture over the paper by means of a flat brush to and fro; finish with a second, then dry. Space will not permit to speak of the technicalities of the manufacture of arrowroot and albumen paper, the less so, as this branch is very seldom practiced by photographers, but by regular establishments for that purpose. We have, however, to speak of the part which the quantity of salt contained in the paper acts in photographic practice. It is manifest, that when a salted sheet, *i. e.*, paper containing metallic chloride, is placed on a nitrate of silver bath, chloride of silver is formed in the paper; besides this a certain quantity of the silver is absorbed mechanically by the paper, thereby containing often chloride and nitrate of silver. To judge of the effects of these two substances, the effect of each must be studied. If these sheets are exposed (one containing only nitrate of silver, the other only chloride of silver, and the third both salts) to the light it will be observed the first will darken very slow, coloring brown, the second color faster, coloring violet, the third very intense and quickly. The nitrate of silver by itself is too insensitive, chloride of silver considerably more so, but does not give intensity of coloring; only by co-operation of the two substances pictures of good intensity are obtained. The cause is this: chlorine, which is set free from the chloride of silver by exposure, acts on the free nitrate, changing it to chloride, which is again changed while exposed to the light, setting free its chlorine, etc., etc. In this manner the sensitive material, *i. e.*, chloride of silver, is formed continually during the exposure. If the free nitrate

of silver forms a chemical combination with the paper material, as is the case with albumen paper, the relation is somewhat different. Here silver albuminate is formed, which, in the pure state, *i. e.*, free from chloride of silver, is sensitive to light, nevertheless the salted albumen paper is preferred.

II. *The Positive Silver Bath.*

For the sensitizing of the picture-bearing material a solution of silver, the positive bath, is used, similar to that in the negative process.

The strength of the latter was formerly taken very high, 1 part of nitrate of silver to 4—5 parts of water. Recently, however, weaker solutions have been employed. We take now 1 part of nitrate of silver to 8—10 parts of water. To take still more diluted solutions is not advisable. Some kinds of albumen paper are only imperfectly coagulated by diluted silver solutions; 1 part of the organic substance is dissolved in the bath, and imparts to it a brown color, and makes it useless.

Even in concentrated solutions, as 1—8 or 1—10, this sometimes happens.

In such cases the bath should be strengthened. Alkaline baths are more apt to turn brown than acid ones, and a remedy recommends itself, *i. e.*, to make the bath acid by the addition of a few drops of nitric acid. Papers that work well do not require this.

Other additions to the silver bath, as citric acid, tartaric acid, etc., are superfluous.

The question whether strong or weak silver baths are preferable was much discussed a few years ago.

At first sight it would appear as if a weak bath would be more economical, but in many respects this is an error. Every sheet of albumen paper, no matter whether it is placed on a strong or a weak bath, absorbs a certain quantity of silver, which is equivalent to the amount of salt it contains, and which is transformed into chloride of silver; another part forms an albuminate of silver, and still another is absorbed mechanically. It is probable that the last-named quantity is smaller with a weak than with a strong bath (an analysis on this point is not at hand).

It is, however, a question whether the employment of a weak bath is advisable for the sake of this problematical saving.

A weak bath is soon exhausted; it becomes poorer with every sheet floated, and soon the amount of silver will be reduced to a point where

it is no longer sufficient for sensitizing, and weak and dull pictures will be the result.

A strong bath loses also by being used, but not nearly in the same proportion as a weak one. It can be used almost to the last drop without serious inconvenience.

A weak bath necessitates long sensitizing; a strong bath sensitizes rapidly and furnishes sheets which, particularly in dull weather, will print much more brilliant than those which have been floated on a weak solution.

Any one who desires to work with a weak bath should take notice of what has been said above; from time to time he should test the strength of the bath (see below the test for nitrate of silver), and fresh nitrate should be added frequently to maintain the standard.

Strong baths do not require this care.

The consumption of silver in the positive process is of particular interest. This depends on different factors; partly on the amount of salt, partly on the thickness of the albumen film; sometimes the length of floating exercises an influence; finally, the more or less rapid removal of the paper from the bath, and the strength of the latter, have to be taken into account.

It is no wonder then that the consumption of silver is stated so differently by different observers.

Davanne and Girard state the amount at 3.76 grains per sheet of 17 × 22 inches. Spiller states 3 grains, and Hardwich states not quite 2 grammes.

As these reports differ so widely, Mr. Meicke made a number of experiments, in the Berlin Academy, to determine the consumption of silver.

500 cubic centimetres of silver bath of the strength of 1 : 8 were made, and from 20 to 25 sheets were floated on it; the bath was tested by Vogel's method for the loss of silver.

The remnant of the bath was again increased to 500 centimetres, and restored to the strength of 1 : 8, and from 20 to 25 sheets were floated on it.

In this manner the bath was strengthened five times in succession, and used over again.

The result was,

From the fresh bath a sheet consumed	2.61	grammes.
" " once strengthened bath a sheet consumed	2.46	"
" " twice " " " "	2.38	"
" " thrice " " " "	2.00	"
" " four times " " " "	2.17	"

We deduce from this the curious result that the consumption of silver is less in an old and strengthened bath than in a new one containing the same amount of silver, and that the absorption of silver decreases with repeated strengthening.

The cause of this may be sought in the fact that the combination of the alkali with nitric acid increases with every sheet, and exercises a peculiar influence on the absorption of silver.

The average consumption is 2.4 grammes of silver per sheet of paper.

In the atelier of Hirsh Nickel, perhaps the largest establishment in Germany for reproductions, the average amount of silver consumed per sheet is equal to $\frac{1}{14}$ of an ounce, or 2.38 grammes.

Lately the sheets being salted weaker, the consumption is still less. Schaarwachter estimates the consumption per sheet to be 1 to 2 grammes, equal to 20 grains.

III. *The Toning Bath.*

The printed picture has an agreeable violet color; it would, however, soon disappear when exposed to the light, as the darkening of the salts of silver would continue, and turn the whole sheet into a homogeneous black. To make it permanent the unaffected salts of silver have to be removed by a fixing agent, such as hyposulphite of soda.

This imparts to the pictures an ugly yellow color. To obviate this, the prints are treated with a solution of gold. They are toned.

The reduced silver of the picture acts on the solution of gold; chloride of silver is formed, and metallic gold takes the place of the silver.

The silver picture is partially changed into a gold picture, and the more completely so, the longer the action is continued. This has a great influence on the color of the picture; when it has been toned for a short time, the color is brownish; longer toning imparts to it a bluish or slaty tint. The color of these toned pictures is but little affected by the fixing bath. The toning process makes the pictures not only more beautiful, but also more durable. Gold is much less subject to atmospheric influences than silver, and a toned picture resists the action of the atmosphere much better than an untoned one.

Next to the duration of the toning process, the reaction of the gold bath exercises a marked influence on the color of the picture. An acid gold solution imparts to the pictures a brownish color; a neutral solution produces a violet tint; and when the bath is alkaline, the resulting picture will be a bluish violet. Which color is the handsomest

or the most suitable is purely a matter of taste, and we find baths of very different reactions in common use. The one recommends this, the next recommends something else.

An important point further is the concentration of the bath. A strong bath acts so energetically on the prints, the color changes so rapidly from brown to blue, that it is scarcely possible to watch the changes. With a strong bath, irregular precipitates are apt to form in consequence of the influence of reducing organic snbstances. It is well to employ very diluted gold solutions, particularly when these precipitates commence to show themselves. Generally it is well to take 1 part of gold to from 1000 to 2000 parts of water.

Gold is a metal which is very easily reduced from its solutions. The action of light alone is sufficient to precipitate brown or red powdered gold from a gold solution. When the water contains only a minute quantity of organic matter—and that is generally the case —the reduction will take place even in the dark. It is no wonder that the diluted solutions of gold, which we employ in the form of toning baths, suffer decomposition so rapidly, although we ascribe to the acid toning bath an unlimited usefulness.

The fact is the latter are the most permanent, the neutral ones are less so, and the alkaline the least.

The latter sometimes lose, in an hour after toning, their yellow color and their usefulness.

According to the investigations of Davanne and Girard, this is explained by a peculiar action of the alkalies.

When a gold solution is mixed with an alkali, or a salt of an alkaline reaction, a mixture will be formed consisting of

$$Au\,Cl_3 + 4\,Na\,O = Au\,O_3\,Na\,O + 3\,Na\,Cl.$$

The salt of gold will readily be reduced by the silver. After a short time, however, the loosely combined oxygen will combine with the NaCl, particularly in the presence of an excess of a free alkali, and a subchlorate of soda and a peroxide of gold and soda will be formed.*

$$Au\,O_3Na\,O + NaCl = Au\,O\,Na\,O + Na\,O\,Cl\,O.$$

The peroxide of gold and soda is in the presence of an excess of an alkali so constant that it cannot be reduced by silver.

When such a bath is mixed with hydrochloric acid, it turns yellow, and chloride of gold is formed. Every bath which has been neutral

* The translator is not quite confident that he has given exactly the proper chemical nomenclature; the symbols will, however, explain.

ized by alkalies has to suffer this change. When, however, no alkalies are present in excess, or when they are neutral, they maintain their toning power, as the acid salt of gold which is formed remains reducible in the absence of an excess of an alkali. Only the toning action is somewhat changed.

In a bath which has not been decomposed only one atom of gold will be precipitated in the place of three atoms of silver.

$$Au\,O_3 + 3\,Ag = Ag\,O + Au.$$

While in a decomposed bath, one atom of gold will take the place of one atom of silver.

$$Au\,O + Ag = Ag\,O + Au.$$

In the latter case the precipitate is more plentiful; the picture retains in such a bath more vigor than in one containing an oxide of gold, in which the intensity is always somewhat reduced. A bath of the former composition is more suitable to the toning of under-printed pictures.

A peculiar kind of toning baths are the so-called soda baths; they are made by adding drop by drop a gold solution to a solution of hyposulphite of soda.

A double salt is formed consisting of hyposulphite of soda and an aureous hyposulphite, which acts analogous to an alkaline bath; but even with an excess of hyposulphite, it remains reducible.

These baths are used after fixing, while otherwise the toning precedes the fixing.

The tones are not so pleasant as the ordinary gold bath. The color is decidedly brownish, and the pictures require a second fixing to give them permanence.

The double salt of Rhodan gold and Rhodan ammonia gives better results.

What has been said above will suffice to make the chemical process of toning understood. We will now give a number of practical formulæ.

NORMAL GOLD SOLUTION, AND THE CONSUMPTION OF GOLD.

We use for the gold bath, solutions of a certain strength of chloride of gold and potassium. This salt, when purchased from the trade, is generally pure, is not influenced by the atmosphere, and is much easier kept than the constantly moist chloride of gold. As a normal gold solution we use

1 part of chloride of gold and potassium,
50 parts of water.

Of this solution we take a certain quantity for immediate use.

On a sheet of paper (17 × 22), about 0.01 gramme metallic gold will be precipitated, besides a certain quantity of the fluid will be taken up by the paper, containing about 0.01 to 0.015 gramme of gold; so that on an average every sheet of paper requires about 0.03 gramme of the gold salt. But, including all the losses, we have to calculate double the quantity of gold, or 0.06 gramme, equal to 1 grain of gold for every sheet of paper.

1. ALKALINE GOLD TONING BATHS.

a. Borax and Phosphate of Soda Bath.

For every sheet of paper

3 parts	of normal solution,	
1½ "	borax, or phosphate of soda, previously dissolved in	
200 "	water.	

The borax solution can be kept on hand in a stock-bottle, and it will only be necessary to measure the proper quantity.

Borax and phosphate of soda are salts with an alkaline reaction; they reduce the bath in exactly the same manner as a free alkali would. The weak boric and phosphoric acids which become free have no marked influence.

The bath will keep only for a short time; it should always be made fresh. When the temperature is low, it is advisable to warm it before use.*

b. Chloride of Lime Bath.

An addition of chloride of lime to the toning bath is in use by many photographers. The effect is that it makes the bath more alkaline (in consequence of the presence of caustic lime), and furnishes, therefore, blacker tones. It is formed in the following manner: by adding to the acetate of soda toning bath (see below) 0.03 gramme chloride of lime, shaking it well, and use after leaving it stand about three hours. The bath will furnish violet black tones. Grasshoff prepared the chloride of lime toning bath as follows: 1000 grammes distilled water, 10 grammes acetate of soda (recrystallized), ¼ gramme chloride of lime, 1 gramme chloride of gold, or chloride of gold and potassium; the ingredients are shaken right well, and after several hours (better next day) several rejected prints (about 6 to 8 card size) are thrown in

* The author generally uses the borax bath.

without previous washing, and left in about 10 to 15 minutes. The bath will turn very cloudy, and the prints very peculiar tones. After removal of the prints, the washed prints are toned with it in the usual manner, toning pretty fast the first few days, 1 gramme of gold toning 11 to 12 sheets very easily, but they must not be toned too blue. If the toning bath tones slower, add a few drops of a solution (15 to 16 drops per sheet), 1 part chloride of gold, or gold and potassium, in 15 parts of water occasionally. Every four to six days, a very little chloride of lime ($\frac{1}{10}$ to $\frac{1}{20}$ gramme is a great deal) is added; blacker tones are the result. The clouded toning bath is filtered every three or four days. (*Photographische Mittheil.*, vol. vii, page 150.) Mr. Paget writes in the *News*, that he toned prints just from the frame, washed in three waters in an acetate of soda toning bath, in which they toned very well. However, a bath of the following preparation would not tone at all,—chloride of lime $1\frac{1}{2}$ grammes, chloride of gold 1 gramme, carbonate of potash 12 grammes, water 4800 grammes. They commenced toning, however, very slowly, as soon as several *unwashed* prints were thrown in. According to this, nitrate of silver is necessary to a chloride of lime toning bath. Bovey therefore recommends the washing of the prints in only two changes of water before toning. For this reason Grasshoff throws several unwashed prints into the lime toning bath. According to Abney, a thoroughly washed print will not tone in a chloride of lime toning bath free from nitrate of silver inside of fifteen minutes, but on the contrary is bleached, and produces fox-colored pictures.

If, however, the washed print is dipped into a solution of nitrate of lead, it will tone rapidly of a peculiar color different than if silver were present. A toning bath of 3 grains chloride of gold and 20 ounces of water would not tone washed prints inside of fifteen minutes, but only bleach them. Partly washed prints, however, tone in five minutes; also pictures soaked in nitrate of lead. It proved that this bath contained hypochloric acid (produced by the action of the chlorine in the gold on the lime). If chloride of lime was added to the bath it toned more regular. Abney concludes from his experiments, 1. That a metallic salt which absorbs chlorine is necessary in a chloride of lime toning bath. 2. That chloride of lime acts as a retarder in toning. 3. In a pure acetate of soda (without chloride of lime) toning bath, the presence of free nitrate of silver is prejudicial.

NEUTRAL GOLD BATHS.

a. With Chalk (after Davanne).

A sheet of paper will require

3 cubic centimetres of normal solution,*
200 water,

Chalk, or carbonate of lime, as much as can be placed on the point of a knife.

The mixture has to be shaken for about five minutes and then filtered. The solution will look yellow when freshly made, but will become colorless after a few hours, without, however, losing its toning properties; but it will tone slower. Pure carbonate of lime is preferable to chalk, as the latter contains organic substances which decompose the gold salt.

b. With Bicarbonate of Soda.

Gold solution and water should be taken as above, and a solution of bicarbonate of soda should be added drop by drop, stirring the liquid constantly, until blue litmus-paper is no longer reddened. This bath does not keep; with an excess of soda it becomes alkaline, and the tones become black. As mistakes are apt to occur in making it, we give the following formula of Mr. England:

3 cubic centimetres of normal gold solution,
3 " " " a solution of crystallized bicarbonate of soda, 1 : 50,
200 " " " water.

The mixture should be used half an hour after it has been prepared. The bath does not keep, and should always be prepared fresh.

3. ACID TONING BATHS.

The Acetate of Soda Bath.

For every sheet of paper

3 cubic centimetres of normal solution,
2 grammes† of crystallized acetate of soda,
previously dissolved in
200 grammes of water,

should be taken.

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* A cubic centimetre is equal to 17 minims.
† A gramme is equal to 15.434 grains.

The bath should be used twenty-four hours after it has been made, and it is only necessary to strengthen it from time to time with a few drops of normal solution. It gives brownish tones.

4. RHODAN GOLD BATH.

I do not recommend hyposulphite of soda baths. Amongst the many that have been suggested, I have not found a single one which has given me satisfaction. But the Rhodan gold bath deserves to be recommended.

It yields the richest gradations in tone that a bath is capable of, according to the length of toning. The fixing with "hypo" changes the tone a little.

The pictures do not require as much overprinting as with other baths, a considerable advantage in dark and cloudy weather. The picture is washed after printing, and placed in the following toning bath:

Gold solution, ...	3 cubic centimetres.
Sulphocyanide of ammonium, . .	20 grains.
Previously dissolved in, . . .	100 grains of water.

The picture turns at first pale and reddish, but finally becomes warm and brilliant, and passes from brown to violet, and finally to black. This bath consumes a little more gold, perhaps as much as 2 grains per sheet of paper.

The bath is kept, and can, by adding from time to time a few drops of gold solution, be used over and over again.

The proportion should be kept in the above toning bath (3 cubic centimetres of normal gold solution contain 0.06 of the gold salt). As for the formula to be selected, we must refer to what has been said above in regard to the neutral, alkaline, and acid bath, which will give the reader sufficient information. It would be superfluous, and perplexing for the beginner, to give him more formulæ to select from. Any one who likes black tones should select the carbonate of soda or chloride of lime bath. To any one desiring brown, I recommend the acetate gold bath, and for purple violet the borax or chalk bath. I generally employ the former.

THE FIXING BATH.

Hyposulphite of soda is used for fixing prints; cyanide of potassium is not admissible, as it affects the pictures very much. The Rhodan

ammonium has never been used much, partly on account of its high price, partly also because it necessitates the use of two fixing baths.

Take a fresh solution of,

2 parts of hyposulphite of soda.
4–5 " water.

Solutions that have been used previously will decompose rapidly, and the pictures are apt to turn yellow.

FAULTS OF THE PAPER.

In the photographic practice of the silver printing process the albumen paper is most generally employed. It is very seldom made in the atelier, but is generally bought from the dealer.

Its quality is, even with the same mode of manufacture, very variable. The white of egg shows in winter different qualities from what it does in summer.

The tendency to change in this least stable substance is so great that it is almost impossible to furnish always the same quality, and the complaints about the albumen paper will continue as long as the silver printing process lives.

Some papers discolor the silver bath in consequence of the dissolution of a part of the organic substances; others turn yellow a short time after sensitizing, tone badly, and become spotted in the fixing bath.

The number of these faults is legion, and their origin is by no means perfectly understood.* Experience has taught us that albumen paper works better when it is not too dry, and that imperfect papers yield better results with a concentrated bath than with a diluted one. It is recommendable to place the paper for twenty-four hours in a damp place, previous to sensitizing. The blisters which are apt to make their appearance on fixing, particularly in summertime, are by it avoided. It is a mistake to try to preserve albumen paper with chloride of calcium in closed boxes.

SECTION II.

THE PRACTICE OF THE SILVER PRINTING PROCESS.

In the practice of the printing process a *perfect negative* is supposed to be at hand. The back of it should be carefully cleaned. If the

* The manufacturer is not always to be blamed, for very often the fault lies with the photographer.

latter is much covered by the retouch, it is well to varnish the same similarly to the front. The cleaned negative is placed into the printing-frame. The pieces of plate-glass are carefully cleansed, the negative is placed on top of it, and the sensitized paper, perfectly dry, is placed on the negative.

SENSITIZING THE PAPER.

The printing bath should be filtered into a clean glass or porcelain dish. A strip of writing-paper should be drawn several times over the bath to remove the scum ; the paper should now be placed on the bath. This work does not require an absolutely dark room, as the paper is not sensitive enough to be influenced much by diffused daylight.

The paper should next be cut into pieces of suitable size (when a large quantity of prints is to be made it is advisable to sensitize whole sheets); the albumen surface should be touched as little as possible in cutting; the paper should be folded with the albumen side upwards, and the fold should be cut from the outside with the scissors. This avoids the soiling of the paper with rust, which is afterwards apt to give rise to black spots. The greatest cleanliness of the tables, on which the silvered and unsilvered paper is placed, cannot be too often recommended.

The paper is placed on the bath by seizing it on two opposite corners; the central part is lowered until it touches the bath, and the whole sheet is gradually let down on the liquid. The movement must not be interrupted, as streaks and lines would be the consequence.

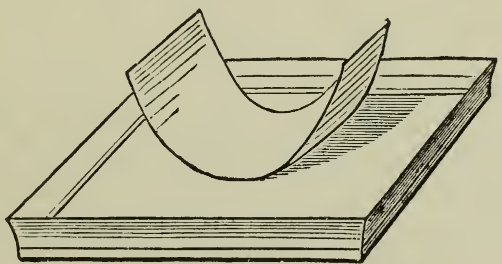
Air-bubbles under the paper will frequently prevent the proper sensitizing of the paper; to remove them the paper should be lifted by one corner; the bubbles should be removed by a glass rod, and the paper placed on the bath again.

The duration of the floating depends on the strength of the bath, the temperature, the albumen, and it is very variable. In summer three minutes, in winter four minutes, are generally sufficient. A sand-glass is very convenient for timing. *Great care should be taken to prevent the solution from touching the back of the paper, as this invariably gives rise to spots.* When the paper is sensitized it should be carefully removed from the bath by lifting it by one corner, and placed in a dark room to dry. At 77° Fahr. the paper dries very rapidly. When the temperature is low a lamp will often very materially assist in drying, but great care should be taken not to scorch the paper. The dried paper should be examined carefully, as sometimes at the corners, sometimes in the centre, damp spots will be found;

these stick to the negative, and many an excellent plate has been ruined by it.

The dry papers should be treated, in regard to handling them, even more carefully than the unsensitized albumen paper. It should be placed into a clean box, and carried in this to the printing-room. A condition for a sharp picture is the intimate contact between negative

FIG. 70.



and paper; this can only be reached by strong pressure. With curved plates we run the risk of breaking them; even with level plates we run this risk, when, as is often the case, glass splinters or grains of sand are present in the copying-frame. The paper should be placed with the sensitive side flat against the negative; a piece of oilcloth should be placed on this; and then a pad, consisting of soft paper or felt, should form the final layer; the cover is now laid on, the springs are fastened, and the printing may commence.

Some papers curl up in drying, and do not lay smoothly in the printing-frame, particularly when they are too dry, or when the printing is done in a cold room; when this is the case it is well to place the paper, after silvering, in a cool place, or place behind it a piece of cardboard; next open one side of the frame, and draw the paper straight; then open the other half of the frame, and draw the other side straight. The frame should not be exposed to the light until we feel fully convinced that the contact is perfect.

The fuming with ammonia is in almost universal use in the United States. It has the advantage, that a diluted bath (1 salt of silver and 20 water) which alone would yield poor prints, will work well, and yield good pictures. Fumed paper will also print more rapidly, and has deeper blacks, as well as clearer whites. With a strong silver bath fuming is of little benefit. In the dry atmosphere of many parts of the United States the fuming with ammonia has the other advantage, that a certain amount of moisture is imparted to the paper. The dry silvered paper is placed, for from ten minutes to half an

hour, in a closet, on the bottom of which a dish with ammonia has been placed.

In Europe we employ the fuming process very seldom.

THE PRINTING.

When all the frames have been supplied with paper they are placed in the light. They should be so arranged that plates of equal density are placed together. It will then only be necessary to examine one frame from time to time, and from the result we can judge of the rest.

The exposure is much longer than when making the negative. With dense positives, and dark or cloudy weather, it may take days, and sometimes the paper will turn yellow before the print is finished. A tolerably good judgment can be formed, by watching the edges of the paper which protrude from under the negative; these become bronzed, and the negative picture commences to show as a positive. But to be perfectly informed in regard to the progress of the work the prints should be examined from time to time; the frame is taken into the room, and in a place that is not too light, one-half of the back is opened, the print is examined, the lid is closed again, and now the other half is examined in the same manner. *Care should be taken not to move the paper, in order that on closing the lid it will resume its original position.*

The print is finished when the finest details in the high lights have become visible, when the protruding corners have become bronzed, and when the intensity of the whole print is a little in excess of what is desired in the finished picture.

The latter is necessary, because some intensity is always lost in toning. Experience only can determine the proper degree to which printing may be carried; it depends also on the character of the negative, and the kind of gold bath that is to be used.

PRINTING VIGNETTES.

To produce pictures in which the background gradually changes from dark to white, it is necessary to cover the negative with a vignette frame. This consists sometimes of a glass plate which is bright in the centre, and becomes gradually darker towards the margin, or simply of a piece of pasteboard, in which a hole has been cut corresponding with the figure on the negative. This piece of pasteboard is placed on the printing-frame. By removing it further from the negative the gradation of tone will become more gentle and gradual. Waymouth's Vignette Papers are the most modern invention and are capital.

Care should be taken that the papers do not change their position; side-light also should be excluded, as it may give rise to undesirable discolorations. It is best to nail the pasteboard on to the printing-frame. When large quantities of prints are to be made, vignette-frames of sheet-iron are advantageous. When white pasteboard is used, it should be blackened. Vignetting is of great advantage when the background is faulty.

PRINTING OF IMPERFECT NEGATIVES.

The printing rules which we have given will suffice for a perfect negative, which has brilliant but not too dense lights, and shows details in the shadows. But we frequently have weak negatives, in which all the details in the lights have made their appearance before the shadows have gained sufficient strength.

These are best printed under a piece of green glass. Experience has taught us that with a feeble light the contrasts become stronger, or, what is the same, the shadows become darker and the lights brighter.

Another way is to cover the back of the negative with varnish in which a little dragon's blood has been dissolved. This varnish will weaken the light similarly to the green glass. On the other hand, we may have strong hard negatives, in which the shadows would be completely burned up, if we would print until the details appear in the lights. We can then help ourselves by covering the black surfaces, when they have reached sufficient density, by suitably cut pieces of pasteboard (masks). Small portions of the lights, that are too dense to print properly, can be brought out by condensing light on them with a lens.

PRINTING WITH SEVERAL NEGATIVES (COMBINATION PRINTING).

It is requisite sometimes to make use of several negatives, or parts of each for one print, similarly to lithography, where several plates are used on one sheet. Work of this kind requires great accuracy, and is not very easy, especially in pigment printing (see below). Take a printing-frame which has good strong hinges attached to the lid. On this the negative is fastened with screws. The paper is fastened on the lower part. If, for instance, a portrait with landscape background is desired, the portrait is printed first in the above frame, everything else being covered on the plate. Then the landscape negative is placed in the frame, in which, contrary to the other, nothing but the space for the figure is covered. For this purpose a

print of the figure is made and cut out carefully, darkened in the light, and laid with great accuracy on the print in the printing-frame, so that the figure will be covered. To prevent the mask from moving, a little gum is placed on it; it has also been proposed to edge the printing-frame with caoutchouc solution. In closing the frame the mask will adhere to the landscape negative. In this manner two negatives fitting together can be made, by means of which, without much trouble, a number of prints can be produced, using one for the figure and the other for the background. It must always fit together without necessitating an inspection, which in pigment printing is very important. The main point is to lay the plates always on the right place, which, in the construction of the frame, is easily accomplished; the negatives, however, must be of one size. If this is not the case they must be previously fastened to a large glass-plate. This frame will answer very well for printing on glass-plates. (See next chapter.)

MEZZOTINTS (HALF-TONE PICTURES).

There is often complaint made that photographic prints are immoderately sharp, and create thereby a bad effect. This in fact is the case with certain sharp features, wrinkles, and freckles in the face. This immoderate sharpness is considerably mitigated and the picture receives a more porcelain effect by placing between the negative and print a thin transparent substance. Take sheet gelatin, which can be purchased at the dealers, or prepared as follows: A large piece of plate-glass is surrounded by a wooden frame, washed clean, dried, and rubbed on one side with oxgall; when this is dry, a solution of gelatin middling warm is poured on, spread evenly, and set away, protected from dust, to dry, which will take one to two days. The edges are then slightly cut with a knife; the gelatin will spring off. Instead of oxgall, plain collodion can be used. The prints are printed in the usual manner until three-quarters done, then place one or two pieces of gelatin between the negative and print, according to the effect desired, which is merely a matter of taste, and finish as usual. This style of printing furnishes nice delicate half-tones, which, however, have a waxen appearance. The same result can be obtained by placing two thin negatives (exactly alike) on top of each other, and printing from them.

OVAL PICTURES (MEDALLIONS) ON A GRAY OR BLACK GROUND.

Pictures of this kind are produced as follows: An oval is cut out of a piece of black paper, the outside is placed on the negative

and printed; the outside, or part covered by the paper, will remain white. The figure is then covered with the oval previously cut out, and printed to any depth desired. See Hearn's "*Practical Printer.*"

THE WATERING.

The prints are taken from the frames and placed in a dark-box, but not in the same one in which the sensitized papers are kept. When all the prints are finished, they should be treated in the following manner:

To keep prints till the following day is only advisable when we are sure that the paper will not turn yellow.

The paper absorbs from the bath a considerable quantity of nitrate of silver; of this only the smallest portion is reduced by the light, and in the printed picture a considerable quantity of free nitrate of silver remains. By decomposing the gold this substance would act very injuriously on the toning bath if it were permitted to remain.* The nitrate is removed by washing. Gutta-percha dishes will answer for this purpose; they are less liable to breakage than porcelain or glass dishes. *It should, however, be a rule to use these dishes for no other purpose, and the washing should be done on a table where an admixture with other chemicals, particularly hyposulphite of soda, is not to be feared.* The sheets are placed, one after the other, with *perfectly clean fingers*, into a dish which is filled with clean water; each sheet should be perfectly wetted; generally the water turns milky in consequence of the separation of chloride of silver. After ten minutes the prints are removed from the first dish into a second one, and the milky liquid is poured in the barrel for silver residues. The same is done with the water of the second dish. When they have been washed in five or six changes of water, or when the water no longer appears milky, the washing may be considered complete. It is not worth the trouble to save the water from the last two washings. The washing should be done in a dimly lit room, otherwise the whites may suffer.

THE TONING.

The picture should be toned as soon as the washing is finished.† The toning bath should be placed in a dish which is solely devoted to this purpose; the bath should be warmed a little in winter-time. One

* When nitrate of silver is mixed with chloride of gold, chloride of silver and metallic gold will be formed, and oxygen and nitric acid will become free.

† Pictures which remain for a long time in water (say about twelve hours) often suffer decomposition and tone unevenly.

print after another should be immersed in the bath, with clean fingers and while agitating the bath constantly. It is necessary that the gold solution wets the pictures equally, otherwise unequal toning will be the consequence. The change of color in the pictures is readily noticed; soon after immersion they assume a brownish violet tint, they next turn violet, violet blue, and finally blue or slate color. As soon as the desired tone has been reached (violet or violet blue is probably the most generally liked), the pictures are taken from the bath and thrown into a dish of water. The toning should also be done in a semi-dark room, otherwise the whites may suffer. Daylight is better than lamplight (but when we are compelled to use lamplight, the lamp should be placed as close as possible to the dish). The most practical way is to place three dishes alongside of each other. To the left a dish with the pictures in water, in the centre the gold bath, and to the right another dish with water. No more pictures should be thrown into the bath at once than what we are able to control, otherwise we run the risk of overtoning. Pictures on plain paper tone more rapidly than those on albumen paper. For the former a very dilute gold bath, or one which has been partially exhausted by being previously employed for albumen prints, should be used.

THE FIXING.

The fixing should be done in a dish especially devoted to that purpose. One by one the prints are taken from the water and placed into the fixing solution. The dish should be moved in order that the liquid may flow at once over the print. Great care must be taken to keep the fingers free from soda solution, as a toned print, which has been handled with "soda fingers" previous to fixing, will invariably show spots. Many use wooden forceps for "handling" the unfixed prints.

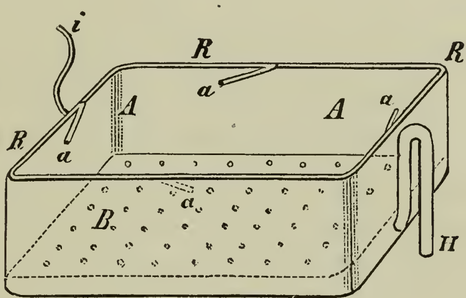
The pictures assume an unpleasant tone in the soda bath, very brown when the time allowed for toning has been very short, at the same time they become paler. Beginners must not be deceived by this. The tone improves after washing and drying, and finally *the intensity becomes the same which the pictures showed in the toning bath.* The latter can be used as a guide. The duration of the fixing process is at least five minutes. Until the fixing process is finished the whites in the pictures will appear mottled or cloudy.

THE WASHING AFTER FIXING.

In the fixed picture a considerable quantity of hyposulphite of

soda remains. If this substance were permitted to stay in the paper, decomposition would soon take place; the sulphur would combine with the silver, forming sulphate of silver, and the print would turn yellow. The thorough washing, the perfect removal of hyposulphite of soda, is hence very necessary. The simplest way to accomplish it is by using frequent changes of water. For an atelier the following can be recommended. *A* (Fig. 71) is a cistern of Japanned tin, with a double bottom; the upper one, *B*, is perforated with holes, like a sieve; *H* is a siphon with its opening at the lowest place of the box;

Fig. 71.



R is a pipe, either provided with small openings, or tubes, *a*, *a*, *a*, *a*; this pipe is connected with the water-supply pipes, or with a reservoir; the size of the siphon, *H*, should be sufficiently large, or of such a diameter, that the box is twice as rapidly emptied of its contents, as the pipe *R* is capable of filling it. The fixed pictures are first placed in a dish with clean water. The vessel, *A*, is now filled with water, and the pictures are placed in it one by one while the water is soon flowing; as the vessel is filled to the top line of the siphon, the latter commences to act, and in spite of the constant addition through the pipe, *R*, empties the box in a few minutes; as soon as this is done its action ceases. The vessel is filled again with water, and the process repeats itself. By such an arrangement it is possible to wash pictures perfectly in from one to two hours, according to quantity; *care should be taken that the prints do not stick together;* when this takes place soda is apt to remain in the paper in spite of repeated washings. To avoid this sticking together, a rotary motion is given to the water by placing the supply-tubes, *a*, *a*, *a*, in an oblique direction, as shown in the figure. The pictures will float in the direction of the current, and when the size of the prints is not large, this arrangement will answer. But when we have large prints, per-

sonal inspection from time to time and removal by hand are necessary; the washing should also be continued as long as possible.

In large establishments the prints are generally washed for a whole night.

Mr. Schade, in Sorau, recommends a constant tilting of the wash-box by an electro-magnetic arrangement.

Sometimes the prints will stick to the sides of the box; to prevent this small holes are made into the lower side of the pipe, *R*, and the water which runs down on the sides of the box will remove the prints which stick to them.

To ascertain if the washing has been carried far enough, the iodine starch test of the author is employed. When the washing is finished, the pictures are separated under water, and a portion of the last water is taken from the box. For the purpose of testing, two test-tubes of equal size, and perfectly clean, should be selected; in each an equal quantity of a solution of iodide of starch* should be placed; to the one tube fresh water from the reservoir is added; to the other an equal quantity from the last water in the wash-box. It is only necessary to shake both tubes well, and to hold them against a piece of white paper, in order to ascertain if in one of the tubes a discoloration has taken place. The greatest cleanliness of the hands and test-tubes is necessary. Even with a millionfold dilution, the presence of soda can be detected. When the test shows that soda, or even a trace of it, is still present, the washing should be repeated. When we wish to test finished pictures by this method, we must soak them first in water, and then test the water as described above. The washed pictures are dried, hung back to back on clean cords in a place free from dust.

Some operators place the prints between blotting-papers; here it sometimes happens that with imperfect washing the blotting-paper becomes gradually saturated with the soda and causes yellow spots on the pictures. Frequently fresh blotting-paper contains soda, as this substance is often added to the paper pulp after bleaching. To test paper for soda, the above described solution of iodide of starch should be dropped upon it. A discoloration will indicate at once the pres-

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* Iodide of starch is made as follows: 1 grain arrowroot is mixed with a few drops of cold water; next about 100 parts of distilled boiling water are poured on it, and afterwards 20 parts of chemically pure saltpetre are added to make the paste keep. To the solution of starch 20 grains of a wine-yellow solution of iodine in iodide of potassium solution is added (a bit of iodine thrown into a solution of iodide of potassium, 1 : 20, will furnish this in a few seconds). This will give a blue solution of iodide of starch, which will keep for about four weeks.

ence of soda. At any rate the drying-paper should be changed very frequently.

THE FINISHING.

The dried pictures are cut to the proper shape; it is best to use a sharp steel knife, a glass table, and glass ruler or form. Right-angled and round or oval guides are used, and for the latter the Robinson Trimmer far excels a knife; very seldom oblique angles. This will easily be understood by drawing a straight line, *a b*, when we erect on it with the guide a vertical line, *c d*, and when we place the guide* to the right and left of *c d*, it has to fit exactly. With smaller sizes, as, for instance, cartes de visite, a glass plate of the exact proportions is often used to cut by. The cut pictures are pasted on Bristol-board, to give them more firmness. The "mount" very often contains hypo; in doubtful cases a test for hypo should be made with iodide of starch in the manner described above.

The board may be either sized or not; the latter are sometimes preferred on account of cheapness, when great quantities of prints have to be furnished. The pictures are pasted very easily, but have the disadvantage that they will draw a great deal in drying; this can be avoided by carefully dampening the back of the mount previous to pasting the print on it.

Very often the mounts are tinted: pale colors should be selected. Care should also be taken that the signatures, and other printed matter, do not contrast too glaringly. When the tint is laid on too heavy it is an impediment to pasting. As a mounting medium common paste is most generally used. It should always be used fresh, and the addition of salts, as for instance alum, should be avoided; such addition frequently spoils the pictures.

An addition of ammonia to the paste prevents the latter from turning acid. To make starch paste, stir solid starch with an equal quantity of water to a thin paste, then pour into it boiling water, stirring continually until you can feel that it suddenly becomes thick. The operation can be reversed, the starch can be poured into the boiling water until it becomes thick. The paste still contains lumps, which are removed by pressing the warm mass through a piece of muslin. Mounting requires practice, but the necessary skill is easily acquired. Many operators use a solution of gelatin for mounting, but I do not find it as convenient as common paste. The mounted pictures are left to dry. When the mounts have not been sized it is

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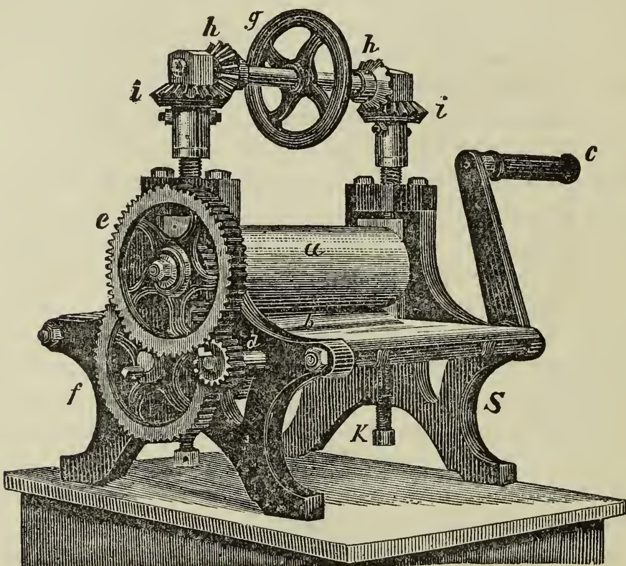
* By a guide a "right angle," ∟, is meant.—TRANSLATOR.

best to place them between blotting-papers and boards, as it facilitates the rolling. The rolling gives smoothness to the pictures. The rolling presses used for this purpose are generally imperfect in construction. The price is so low that little can be expected.

The press consists of a steel plate* (Fig. 72), on which the mounted picture, with the picture-side downwards, is placed; it is pushed between parallel cylinders, *a*, *b*; parallelism is secured by the screws, *K*. Before placing the plate between the rollers the adjustment is carefully made by examining the distance with the eye. The plate is now placed in position, the rollers are screwed together by turning the

Fig. 72.



wheel, *g*, and plate and cylinders are carefully cleaned. To ascertain if everything is clean and in good working order a piece of white Bristol board is passed through. The pictures are placed on the plate perfectly dry, otherwise they will stick. The retouches should be laid on before rolling. For small sized pictures, small presses with smooth rollers and without a plate have been made; they are very convenient.

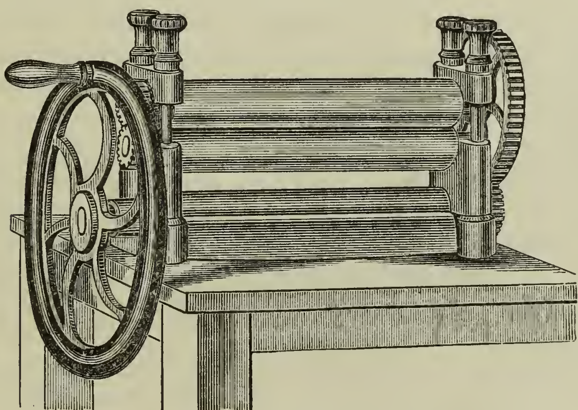
Large pictures should be as even as possible previous to being

* In order to show the cylinder and cog-wheels the plate has been omitted in the illustration.

placed in the press; a slight moistening of the mount previous to placing the picture on it, and drying between blotting-paper under pressure, will secure this result. If the pictures have curved very much by drying, it is well to press them straight with the backs over the sharp edge of a table repeatedly until they remain flat.

In the Excelsior Press of the Scovill Manufacturing Company, N. Y., which is in common use in America, the steel plate is dispensed with. This reduces the cost very much, and makes a very desirable press. The gearing shown in the figure below makes the adjustment very easy, and it is a very good press.

Fig. 73.



Lately Mr. Entrekin has introduced a machine, in which the plate can be heated. Pictures pressed with a hot plate receive an extraordinary gloss, more so, and nicer than with wax. In Germany a method is in vogue, whereby pictures are made very glossy with gelatin; such pictures are called enamelled or glacé pictures.

SECTION III.

GELATINIZING OF PHOTOGRAPHS, AND ENAMEL PICTURES.

If a finished paper photograph is moistened with the tongue it assumes an unusual brilliancy, the cause being that one part of the picture being beneath the surface, is only visible when the surface is made transparent. This transparency disappears as soon as the paper dries. The transparency can be made more lasting by rubbing with cerate, to be had at the dealers, or with an emulsion consisting of 1 part

of white wax in 100 parts of ether; this also soon becomes dull, it penetrating into the paper. A very pretty method, although not adapted for vignettes, is to burnish them with a press in which the plate is heated. Instead of this, the method of gelatinizing, which we will describe below, has become in vogue. For this, two warming-bottles,* made of tin plate, which have the shape of a right-angled box, are requisite (one of 12″ square, and $2\frac{1}{2}$″ in height, the other of 9 × 3″ square, also $2\frac{1}{2}$″ height) having on one end a small tube for filling. The large one is used to heat the collodionized plate previously to using the smaller one as a warm support while gelatinizing. The purpose of these bottles is to keep the prepared collodion plates slightly warm until ready for the operation, to prevent any interruption while working the gelatin solution, which is apt to cause blisters. Small plates of plate-glass, size 5 × $3\frac{1}{2}$″, are necessary, and are coated with plain collodion and dried. Before commencing both bottles are half filled with water. On the upper surface place a piece of card of corresponding size; this is done for two reasons: first, to prevent the glass plates from touching the tin; second, to keep the gelatin clean, which is apt to drop out during the operation, for further use. The gelatin solution consists of 1 part of clean gelatin and 8 parts of water. The gelatin is cut into small pieces, put in a stone-ware cooking-jar, cold water poured on, and dissolved, continually stirring with a glass rod, with a gentle heat; afterwards strain through a close linen into the gelatin apparatus. Cartes de visite and cabinet photographs are usually mounted on cards with name of the firm on the back, and in the usual manner, touched, pressed, and finished. Those intended for gelatinizing are only discerned from the others by being somewhat larger. For subsequent trimming, the size of the cards is marked with a lithographic square. A very frequent cause of failure in gelatinizing cartes de visite, is that the edges, during the operation, or later, in taking off the glass, are injured; by using larger cards the latter can be avoided. To avoid the first, a simple method is given below.

All preparations being in readiness, operate as follows: Several collodionized plates are placed on the large warming-bottle, film-side up, for a previous warming. One being placed on the smaller one, a carte de visite is dipped in the warm gelatin solution (face upwards), and after a short pause picked out in such a manner (horizontal, if possible), that a sufficient quantity covers the picture. The picture is now laid with the long edge on the edge of the plate nearest the operator, at

* A warming-box would be more appropriate.

the same moment leaving the whole picture come down on the plate. Hold with two fingers of the left hand, the short edge lying nearest, and rub the back with the middle finger of the right, in short regular strokes, commencing at the furthest edge, over the whole picture. Six to seven strokes made with the breadth of the last joint of the middle finger with a slight pressure, are sufficient to remove all superfluous gelatin solution, at the same time any bubbles contained therein. In making the strokes, care must be taken that between the strokes no space is left untouched, as blisters will then surely remain. The gelatin must in a certain manner be forced from the front edge to the opposite. Herewith, as already mentioned, all bubbles are certainly removed.

The backs of the pictures are then cleaned of the gelatin solution remaining with a sponge dipped in warm water, and the plate with the glass side up is placed on a thoroughly wet and flat piece of flannel until the gelatin has set. This is the method mentioned above to prevent edges coming off directly after gelatinizing. If the card side of the gelatinized plate is laid on top, they would dry very rapidly, causing shrinking, and a sure coming off at the edges. Being done with gelatinizing, all plates can be turned and dried in an ordinary room temperature. The best time for gelatinizing is in the evening; the next day, about 8 or 9 o'clock, the pictures can be removed from the glass. The removal will be difficult if the foregoing manipulations have not been closely followed or indifferently. The pictures are often cameoed. For this purpose cameo presses are used, in which the picture is laid and pressed. Chute's is the best form.

SECTION IV.

CARE OF THE UTENSILS AND CHEMICALS IN THE POSITIVE PROCESS.

Care of the Negative.

Negatives are the photographic printing plates, and the photographer has to bestow care on their preservation in proportion to the number of prints which he expects to take from them; this becomes the more difficult, as on the one hand the material is the most fragile in existence; on the other hand, the printing surface, *i. e.*, the *varnished collodion film*, offers, when compared with a lithographic stone or a copper-plate, a very soft and easily injured surface. When we add to this the almost indispensable negative retouch, which, in the shape of india-ink or oil paint, is placed on the glass or on the var-

nished surface, and which can be rubbed off with the finger, and when we consider further, that for the prints a paper is used, impregnated with one of the most caustic substances—nitrate of silver—which, of course, exercises its influence on the varnish, we cannot help feeling surprised that a negative actually lasts as long as it does. Let any one touch a negative, from which a dozen prints have been made, with the point of the tongue, and he will be surprised how strongly it tastes of nitrate of silver.

This circumstance alone indicates chemical changes in the negative during printing. The silver salt is partly absorbed by the varnish, the latter becomes colored by the light—generally yellowish—and, with a large edition, the last prints appear harder than the first impressions.

With a weak negative this may sometimes be an advantage. Another change, but a much more dangerous one, is caused by moisture. Mr. Stiehm communicated to the *Mittheilungen* the result of an experiment which showed, in a characteristic manner, the influence of moisture. He placed damp blotting-paper on a negative, and twelve hours afterwards it showed cracks. These cracks, unfortunately, appear too often on their own account, and spoil many a beautiful negative. They happen most frequently with plate-glasses, and we once heard the remark that they only happen with them. My experience teaches me, however, that other glass is equally liable to this fatality, although not so frequently, and I feel convinced that moisture is the main cause of its origin. It has happened to me, that of a number of negatives, which were made at the same time and under similar circumstances, some, which had been handed to the printer, became cracked, while the others, which remained undisturbed in the closet, showed no such tendency. And here the fact established itself that a negative which had been kept in a very damp place showed this tendency soonest; and, further, that gross carelessness of the printer, who had employed imperfectly dried paper, caused the balance of the injury. Too much license is given to the printer. In no place is strict surveillance more necessary than here; they hold in their possession the treasure of the photographer, and how do they treat it? I have noticed myself that in printing-frames, which were removed at the beginning of a shower, the pad at the back of the negative had become moistened, and still the printer did not consider it worth his while to replace it by a dry one.

The consequences of such carelessness are easily imagined. They may not manifest themselves at once, but after the twentieth or fortieth impression the varnish will show cracks. Most proprietors have

no idea how many negatives are totally destroyed by grains of sand insinuating themselves into the printing-frame; or how many films are scratched by careless handling.

These circumstances explain the variable permanency of the negatives in our galleries.

Some photographers preserve their negatives in plate boxes; this method can only be recommended when the boxes are made of dry and well-varnished wood. It is much better to keep them in airy closets in a dry room, and I consider it as advantageous that the closets are removed a little from the wall, so as to permit a current of air to circulate around them.

I have noticed that leakage in the roof admitted water into the negative storeroom; it manifested itself as a damp streak along the wall, which, while covered by the closet containing the negatives, was not noticed, until finally the moisture penetrated through the wooden partition of the closet, and became visible. The result was that some valuable negatives were lost by cracking of the film. I must also mention another characteristic circumstance. The author noticed that the plates which were made in the moist climate of Aden showed an exceedingly tender film, while, on the other hand, those that were taken in the desert showed no such delicacy. In the production of the negative, moisture plays an important role as regards permanency. The author's experience leads him to reject a caoutchouc solution previous to varnishing as unreliable; on the contrary, it makes the film more tender.

It has been recommended to treat the negative to a solution of gum Arabic, 1: 30, previous to varnishing. But such plates are not insured against cracking either.

The restoration of cracked negatives offers other difficulties; the method which has frequently been suggested, of exposing the film to the vapors of alcohol and ether, by placing it on a dish containing these two fluids, has been frequently recommended; but it is not always successful. The cracks do not always bear the same character; many of them are thrown up, like the burrows of a mole.

The latter will disappear almost completely when we place the negative over a dish containing a little alcohol. The varnish becomes soft in twenty-four hours, and the outlines of the cracks coalesce.

The negative is warmed afterwards in order to harden the varnish.

Another kind of cracks are the so-called hard lines; they are not elevated, but depressed; they can be partially removed by rubbing them over with gray silver powder (silver precipitated by sulphate of iron).

Some will disappear by pressure with the finger-nails; but the vapors of alcohol will not obliterate them. Warming of the plate will sometimes remove them completely; but unfortunately they will reappear after awhile.

Under such circumstances a process which *enables us to multiply negatives* becomes for the photographer absolutely invaluable. We will consider such a method in one of the subsequent chapters.

THE CARE OF THE PAPER.

The photographic paper, which is stored in a dry place, will keep for a considerable period. It seems almost as if albumen paper which has been on hand for some time would give better results than fresh paper.

In the albumen film itself changes take place in course of time; gases are developed, and, sometimes, the products of decomposition may affect the process injuriously. It is, for instance, an established fact that good albumen paper, which had been sent to America in soldered tin boxes, on its arrival proved worthless; but after being exposed to the air for some time it yielded good results. This circumstance seems to make the keeping of albumen paper in an airy room advisable.

Another circumstance which influences the paper very much, is the state of dryness of the albumen surface.

When the latter is very dry, for instance, in the heat of the summer, we notice that the paper repels the bath as if it was greasy, and becomes covered with small blisters; when placed in the wash-water, on leaving the fixing solution, these blisters sometimes disappear again, and at other times they break and spoil the picture.

They can be avoided by placing the paper twenty-four hours before use in a damp cool place, a cellar, for instance.

If blisters still make their appearance, the paper should not be placed in water at once after leaving the fixing solution, but should be immersed in a solution of hypo twice as weak as the fixing bath, next in one four times as weak, and finally washed in water.

The abovementioned facts demonstrate that the paper should possess a certain degree of moisture in order to secure good results.

This refers to silvered paper also. When we place silvered paper in a box with chloride of calcium, the latter will deprive it of all its moisture; it will keep white for a long time, but it will fail to give satisfactory results.

The turning yellow of silvered paper is an evil which in summer-

time gives much trouble to the photographer; it shows itself particularly with papers that have been made with old and fermented albumen; the yellow color disappears in the gold and fixing baths partly, particularly when we add to the latter a one-thousandth part of cyanide of potassium. Still pictures taken on such paper lack brilliancy.

Silvered paper will keep white longer, if copperplate paper, previously soaked in bicarbonate of soda and dried, is placed back of it. Oil cloth acts similarly, probably in keeping off the gases formed in the printing pad, which have a reducing action.

THE CARE OF THE POSITIVE SILVER BATH.

The positive bath is not liable to near as many accidents as the negative bath. Microscopic quantities of organic substances or acids will affect the latter to some extent, and sometimes make it useless. The positive bath is not affected by impurities in such small quantities. It is evident that the impurities must increase with every additional sheet of paper, as the nitrates which are formed by double decomposition pass into it; still they do not seem to hurt, but on the contrary exert a beneficial influence, as the absorption of silver from an old bath is less than from a new one.

Organic impurities also pass from the paper into the bath. The condition of the albumen used on the paper is quite variable; on some papers it is laid on fresh, while in other cases it is first subjected to fermentation. Its chemical properties are not the same, and so it happens that some papers impart so much organic matter to the bath that after a few sheets have been silvered it will turn brown. In this state it is unfit for use, as the paper cannot be evenly sensitized upon it.

Fortunately we possess in the permanganate of potash a remedy which will restore a bath so discolored instantly.

The method is the same as described above, when speaking of the negative bath.

Formerly a bath which had turned brown, was exposed to sunlight; this led to the same result, but the process was much slower.

Besides its strength, we have to consider the reaction of the bath. A neutral bath is in the most favorable condition.

But it happens frequently that a bath, which is neutral when new, turns gradually acid, when the albumen paper has an acid reaction; in this case the bath is apt to turn brown, and the pictures are gray and weak. Testing with litmus-paper, and the addition of a little solution of soda, will easily remedy this. To keep a bath neutral, the

addition of the carbonate of the oxide of silver is very good; it is put into the stock-bottle; it is easily made by adding a little carbonate of soda to the bath. Some papers will stand an alkaline silver bath without detriment; these papers generally contain a certain quantity of free acid.

Some manufacturers intentionally add organic acids to the albumen, for instance, citric acid; it produces a more reddish tone, and keeps the silvered surface white for a longer time.

I do not think that such additions are advisable. A portion of the acid enters the bath, and seems to impart to it a red color under certain circumstances.

A bath with an alkaline reaction sometimes attacks a film which is easily soluble. A weak acid, such as acetic acid,* is the best for neutralizing it.

Another change in the bath is produced by the loss of the silver salt.

With a very strong bath (12½ per cent. and more) this circumstance does not amount to much, for even when the amount of silver has been reduced as low as 5 per cent., the bath will work well, *provided the paper is of good quality.*

Otherwise the deficiency of silver soon manifests itself by the *weakness of the prints.* The shadows do not appear vigorous; the lights are gray, and the picture is monotonous; sometimes it will cause the *peeling of the albumen film.* It is therefore absolutely necessary that the bath should be tested from time to time, and fresh silver salt added according to circumstances.

For this purpose instruments called hydrometers are used; they are placed in the bath and sink into the liquid according to the specific gravity of the same; they are provided with a scale divided in degrees, and by noticing the degree indicated by the surface line of the liquid in which the hydrometer floats, the percentage of silver salt contained in it can be ascertained by consulting a properly prepared table in which the degrees of the hydrometer are converted into per cents of silver.

If the indications of this instrument were reliable but little objection could be raised against its use; but it is well known that the indications are influenced in the highest degree by the presence of alcohol, ether, acetic acid, and different salts, to such an extent that the test

* According to a statement by Mr. England, a brown bath is restored by boiling it from 10 to 15 minutes. The organic matter separates with a part of the silver.

not only becomes useless, but even worse, because the wrong indications mislead, deceive, and produce errors of the most fatal kind. These experiences make the introduction of a reliable silver tester a necessity.

Gay-Lussac gave us such a method in the so-called triturating process with chloride of sodium. A solution of chloride of sodium of a given strength is added to a silver solution until no further precipitate of chloride of silver takes place. The quantity of the chloride of sodium solution necessary to precipitate all the silver determines the quantity of the latter. Unfortunately this method has a drawback; the cloudy appearance of the liquid makes it very difficult to ascertain the precise moment when the precipitation of chloride of silver ceases. The following method of the author is free from this error.

This method is based on the peculiar action of iodide of potassium on solutions of nitrate of silver on the one hand, and nitric acid on the other hand. When iodide of potassium is added to a solution of nitrate of silver, a precipitate of yellow iodide of silver will be formed; when iodide of potassium is added to a thin solution of starch paste and nitric acid, *containing a small quantity of nitrous acid*, iodine will at once be set free, which imparts to all of the liquid a deep blue color.

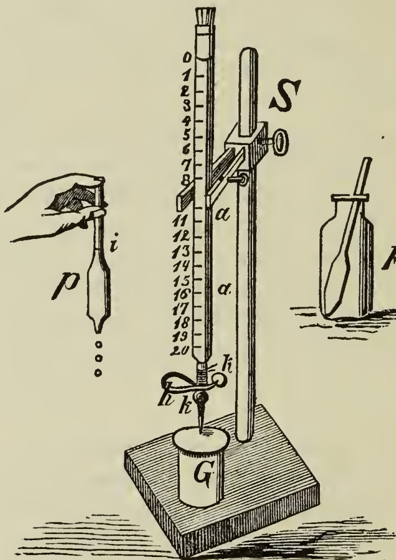
When we add a solution of iodide of potassium to a mixture of the solutions of nitrate of silver, nitrous acid, and starch, the two processes will take place simultaneously; iodide of silver will be formed as a precipitate, and free iodine, which in the presence of starch paste imparts to the liquid a *blue* color. But so long as a free salt of silver is present in the solution, this blue color will disappear at once on agitation, and the liquid will assume a pure yellow color. When we continue to add the solution of iodide of potassium drop by drop, we will soon arrive at a point where the blue color no longer disappears on shaking the liquid, but remains permanent; this indicates that *all the free salt of silver has been precipitated*, and from the quantity of iodide of potassium solution which was necessary to produce this result, it is easy to determine the quantity of silver which has been precipitated. The point when all the silver has been precipitated is ascertained by the blue color, with *surprising exactness;* a single drop of iodide of potassium in excess suffices to give to all the liquid an intense and permanent blue color. (When iodide of silver is present in large quantities the color will be more green than blue.)

To employ this method practically, a solution of iodide of potassium, which contains in 1023.4 cubic centimetres exactly 10 grammes chemically pure dried iodide of potassium, is prepared. One hundred

cubic centimetres of this solution will precipitate exactly 1 gramme of nitrate of silver; hence, when we take for a test 1 cubic centimetre of silver solution, each cubic centimetre of iodide of potassium solution will indicate one per cent. of silver salt.

This solution is carefully poured into a Mohr's spring compressor

Fig. 74.



burette,* avoiding air-bubbles (the burette is divided into $\frac{1}{5}$ cubic centimetres). The burette is placed into the holder, *S* (Fig. 74); the spring compressor, *h*, is opened by pressing the button, *k*, and the liquid is allowed to run out until the lower curve of the surface of the liquid touches the point 0 (zero). It is necessary that the spring should at first be opened to the full extent, in order to expel the air and old solution which may have collected in the lower part of the tube. This must not be overlooked.

When this has been done, the cleaned and dried pipette, *p*, is dipped into the solution of silver which is to be tested;† the air is

* These spring compressors are very convenient; the operator can at his pleasure allow the liquid to run out drop by drop or in a stream.

† It is self-evident that the pipette must be perfectly clean and free from old solution, otherwise it would mix with the new solution, and change its

sucked out with the mouth, and when the tube is nearly filled, the upper opening is quickly closed with the dry index finger, the pipette is taken out of the solution, and by lifting the finger gently the fluid is allowed to run out until it reaches the point *i*. The lower end of the pipette, which holds now exactly one cubic centimetre, is held against the side of the glass *G;* the fluid is forced into the glass by blowing in the upper end of the pipette. Instead of the glass a test-tube may be used; the latter is more convenient for shaking. (The small remnant of the fluid which may remain in the point of the pipette is of no account.) Afterwards add one drop of nitric acid and about one drop of a solution of 3 parts nitrite of potassium (not nitrate) in 100 parts of water; finally 10 to 15 drops of starch solution* are added. Now the test may commence. The burette should be examined once more, to see that the exact quantity of fluid is contained in it. The glass is lifted up high with the left hand. The spring compressor is opened carefully and a few drops are allowed to flow into the glass; when the silver solution is strong, a yellow precipitate will be formed at first, which will afterwards change to blue; when the solution of silver is weak, the blue color will show itself at once, but will disappear again on shaking the glass. In the former case, the iodide of potassium solution may be added more freely; in the latter case more caution should be exercised. The glass, *a*, should be constantly shaken to mix the fluid thoroughly.

Finally the blue color will disappear more slowly; great care is now necessary, as a single drop may suffice to produce a blue or green color, which will not disappear again on shaking. The spring compressor is now closed, and the height of the fluid is read off the scale; when this indicates, for instance, $7\frac{3}{5}$; then the silver solution contains $7\frac{3}{5}$ per cent., or in 100 cubic centimetres $7\frac{3}{5}$ grammes of silver. It is not at all difficult to observe one-tenth of one per cent. on the scale. Those who are not accustomed to work with burette and pipette will handle them at first rather awkwardly; but a little practice will soon give them the necessary confidence.

With strong silver solutions it is advisable to add, near the close of the operation, a few drops of starch solution, particularly when the color is not very decided; with brown positive baths the color is

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character. In practice it is sufficient to fill the pipette, empty the contents, and fill it again; by repeating this operation twice or three times, the solution will be clean enough for all practical purposes.

* To make the starch solution, put a pinch of starch-powder in a test-tube, fill with water, shake, and boil. The solution must be cooled before using.

always somewhat dirty; still, with a little extra care, the determination is not difficult.*

When with pure silver solutions the blue color appears dirty at the start, or not at all, then the starch paste is spoiled, or the nitric acid does not act. The former is easily made again; the latter will act when a few pieces of sulphate of iron are added (see below). If the operation should fail from the above reasons, or from want of skill of the operator, it is very easy to repeat it.

The burette and the iodide of potassium solution should be closed with well-fitting corks when not in use. A pound of iodide of potassium solution will, according to the strength of the solutions to be tested, suffice for from 30 to 50 tests.

THE CARE OF THE SENSITIZED PAPER.

It is a general complaint amongst photographers that some papers turn yellow very rapidly after they have been sensitized. A positive remedy for this evil has not been found as yet, but it is certain that it can be partially obviated.

1. By keeping the paper in a very dry place. Drying boxes and tin cases with chloride of calcium have been recommended; but I must caution against their use; they preserve the paper, but the paper prints badly; the cause of it is that the printing process—which is a chemical decomposition—can only take place in a normal manner in the presence of a certain quantity of moisture.

2. By placing at the back of the sensitive paper, in the printing-frame, a piece of *waxed paper*. In the printing process, gases are developed which exercise a reducing influence; these are absorbed by the pad (consisting generally of felt or blotting-paper), and cause the paper to turn yellow rapidly. A piece of wax paper will prevent this.

3. In order to make the silvered albumen paper more permanent, the addition of citric acid has been recommended.

Ost uses the following bath:

Nitrate of silver, ...	1 part.
Water, ...	12 "
Citric acid, ...	1 "
Alcohol, ...	1 "

* For strong solutions (positive bath) one-half cubic centimetre is sufficient for a trial. But the degrees of the burette which are obtained must be multiplied by two.

4. Mr. Haugk writes, that when ordinary albumen paper is washed, *after it has been silvered,* and all the free nitrate of silver is removed, it will keep white for a long time, and by fuming it with ammonia, it can be made as sensitive as carbonate of silver paper.

The author has tried this process and found that it worked excellently.

THE CARE OF THE TONING BATH.

The toning bath is not very permanent; this is owing to the unstableness of the salts of gold. Alkaline toning baths must always be made fresh immediately previous to using them. Acid toning baths, and those containing rhodan gold, will keep longer; they should be strengthened from time to time. But here also a freshly made bath is preferable.

The residues of the toning bath are filled in large bottles or jars, and from time to time a little solution of sulphate of iron and hydrochloric acid are added; the gold is precipitated in the form of a brown powder, and can be collected and reconverted into chloride of gold.

This process is not adapted to rhodan gold baths or those containing hyposulphite of soda.

THE CARE OF THE FIXING BATH.

The fixing bath does not keep well; it should be frequently renewed, as with prolonged use decomposition will take place, and sulphate of silver is formed, which causes the prints to turn yellow.

SECTION V.

FAILURES IN THE POSITIVE PROCESS.

1. FAILURES IN SILVERING.

1. Blisters (see remarks thereon).

2. The paper repels the silver solution; this is caused by the albumen being too dry (see further remarks thereon).

3. The silver solution hangs in drops in the middle of the sheet; this is remedied partly like 2. The drops can also be removed with blotting-paper.

4. The paper is dried too much or too little, printing in such cases weak or uneven, or ruins the negative.

5. Coloration of the bath (see remarks thereon).
6. Gray dirt from careless skimming (see remarks thereon).

2. FAILURES IN PRINTING.

1. The picture appears flat, the shadows weak, the lights clouded and dim. Cause: Acid silver bath, or old, or weakened silver bath; dried too rapidly or not enough (see above); damp printing-pads. Thin negatives; these are printed under green glass, or varnish the front with a varnish containing dragon's blood.

2. Clouded lights are caused by repeated examination of the prints in the broad daylight.

3. Yellow paper, caused by long printing (see Instructions on Printing).

4. Brown streaks. Cause: Remains of fibrin in the albumen.

5. The print is partly not sharp. Cause: Insufficient contact, in consequence of not enough pressure in the printing-frame. The paper becomes wavy. This occurs when the difference in the temperature in the silvering and printing room is too great. Remedy: Leave the paper in the printing-room half an hour before printing.

3. FAILURES IN WASHING.

1. Black precipitates are formed, from substances containing sulphur in the water, or the remains of hypo in the dishes, especially in gutta-percha ones.

2. Brown-black spots are formed by touching with fingers full of, or not free from, hypo.

4. FAILURES IN TONING.

1. The print tones unevenly. Cause: Not enough toning solution; insufficient movement of the prints while toning; sticking together of the prints, thereby preventing the solution from acting on them; leaving the prints lay too long before toning.

2. The prints will not tone. Cause: (*a*) The bath contains iodide of silver, too much acid, or a great quantity of foreign metals (see how a positive bath is made out of a negative bath). The bath is boiled (after removing the iodide, by thinning it with four or five times its volume) until dry, and fused gently for some time. The acid will evaporate, and the foreign metals will in a great degree be reduced; (*b*) The wash-water is polluted with sulphur-containing substances, (see above); (*c*) There is not enough gold in the solution; (*d*) The pictures are washed too much This applies only in applying the lime toning bath (see remarks thereon).

3. The whites are discolored if the toning is done in too light a place.

5. FAILURES IN FIXING.

1. Streaks are formed in consequence of uneven immersion into the fixing solution, or spots, from splashing on prints not yet immersed.

2. Yellow spots (often only visible after finished) cause blisters on the paper. Remedy: Shaking each print separately in the fixing solution, or brushing with a soft pencil.

3. The fixing solution is stale, or not sufficient for a large quantity of pictures. Yellow spots will show in course of time.

4. Cloudy-looking spots are caused by the prints not remaining long enough in the fixing solution.

6. FAILURES IN WASHING AFTER FIXING.

1. The pictures become pock-marked; 2. They stick together on the sides of the washing tank, and turn rapidly yellow in consequence of the remaining hypo; 3. They are not sufficiently washed (see test for hypo).

7. FAILURES IN FINISHING.

1. Danger in drying between blotting-paper; defective card-mounts.

2. Faulty paste; accidents or failures in pressing and burnishing.

SECTION VI.

THE REDUCTION OF SILVER RESIDUES.

Of the large quantity of silver which photographers use, particularly in the positive process, we find, according to Davanne, about,

a. 3 per cent. in the finished picture.
b. 7 per cent. in the drippings, filters, paper trimmings, and in the paper with which wasted solution has been wiped up.
c. 50 to 55 per cent. in the wash-water of the exposed paper in the form of a silver salt.
d. 30 to 35 per cent. has been passed into the fixing bath.
e. 5 per cent. at most in the wash-water of the fixed prints.

To recover these residues is financially a matter of great importance. Usually photographers collect the first wash-water in a barrel, and precipitate the silver with common salt. An excess should be avoided, as it will retard the precipitation of chloride of silver.

After twenty-four hours the clear water is drawn off the precipitate, and silver water is collected again; when this process has been repeated for months, the precipitate of chloride of silver is collected on a cloth, washed with water, and dried.

The silver which has been recovered from the *developing solution* (negative process) may be added to the above.

To reduce the dry mass the melting process is the most suitable.

A good Hessian crucible is heated in a furnace to a red heat, and *gradually* the following *perfectly dry* mixture is introduced:

Chloride of silver residue, ...	3 parts.
Carbonate of soda, FREE FROM WATER,	1–½ "

It is well to rub the inside of the crucible with chalk or white clay, previous to heating it.

The smelting should be continued until the whole mass, which at first froths very much, flows evenly; it is then allowed to cool, the crucible is broken, and the button of silver is taken out.

Fixing waters of hyposulphite of soda are collected separately in large earthen jars, large enough to hold the water of two days, or the fixing bath and the first water after fixing of from 4 to 6 days. In each jar a bright copper plate is placed, or better still two plates opposite to each other. The metallic silver will collect on these plates in 48 hours, and can be removed with a stiff brush. The precipitate which has been brushed from the plates may be taken out at once, or it may remain until a sufficient quantity has collected for smelting purposes; at all events after brushing off the precipitate sufficient time should be allowed for it to settle.

When it is removed from the liquid, it should be filtered either through linen or paper, according to quantity, and be dried in the open air or on a stove.

After this mix

100 parts of the washed and dried silver powder,
50 " melted and powdered borax,
25 " " " " saltpetre.

The saltpetre has to oxidize the particles of copper which have been removed by the brush. The crucible is filled one-third full with the mixture, and when the foaming has ceased it is heated for about twenty minutes longer on a brisk fire; the mixture is then allowed to cool, and the crucible is broken.

The resulting metal contains some copper, but this does not do any

harm; it can be used for producing the silver salt by dissolving it in nitric acid.

Papers containing silver should be collected and burned; the ashes are collected, and when all organic matter has been removed by heat, a mixture should be made of

100	parts of ashes,	
50	"	dry carbonate of soda,
25	"	quartz sand.

The melting goes on rapidly, and the result is a quantity of silver varying from 20 to 60 per cent., according to the composition of the papers.

An important point for America is the method of precipitating the waste silver water. As the precipitation is patented, another expedient has been brought into requisition, which consists in the use of a galvanic battery, which reduces the silver in such water to a metallic state. (See *Philadelphia Photographer*, report of the German Photographic Society of New York.)

CHAPTER VI.

DIFFERENT PHOTOGRAPHIC PROCESSES.

SECTION I.

PERMANENT SENSITIVE NEGATIVE PLATES (DRY PLATES).

THE processes described in Chapter III, the silver negative and positive processes, are at present those universally practiced, and are adapted to solve a multiplicity of photographic problems. There are also beside these many others but seldom used in practice, which are advantageous under certain circumstances, such as easier and convenient working (like dry plates for landscapes), or the production of a peculiar style of picture (transparent positive, pigment prints, porcelain pictures, etc.), which are often desired by the public. The most important of these processes we will describe in the present chapter.

SUMMARY AND SUCCESSIVE OPERATIONS IN THE SILVER-POSITIVE PROCESS.

1. *Preparations.*

Filtering and skimming of the silver bath.
Cutting of the albumen paper.

2. *Operations.*

Sensitizing in a darkened room.
Drying in a darkened room.
Cleaning the negatives.
Preparing the negatives.
Laying and pressing of the sensitive paper in the printing-frame (in a darkened room).
Exposing.
Occasional examination of the prints during the exposure (in a dark place).
Washing (all the prints in four changes of water).

The negative process requires a *dark-room* for the preparation of

the sensitive plates, which the travelling photographer has not always at his disposal. It furnishes wet plates, which dry rapidly, and after a short time become useless. It has been tried to obviate this difficulty by making permanent sensitive dry plates, which can be prepared at home, and carried along on an excursion. Such plates should retain their sensitiveness for a long period, and should not require development until after the return home.

Permanent sensitive positive paper has also been prepared, which, when bought ready made, obviates the unclean work of silvering, and is not liable to the danger of turning yellow in the printing-frame.

Very great efforts have been made to produce permanent dry plates and permanent sensitive papers, which, as regards certainty and beauty of the results, should be equal to the wet process. Every day new dry processes and new sensitive papers make their appearance. It is doubtful which method is the best. So much, however, is certain, that the production of dry plates, as well as sensitive paper, is still very unreliable, and in spite of the greater expenditure of care and time, which the preparation of these bodies makes necessary, success cannot be guaranteed in the same measure as with the wet process.

While in practicing the latter perfect cleanliness is a *conditio sine qua non,* it is still more so in the dry process.

The abovementioned common fault of negative plates getting spoiled by the drying of the silver solution is obviated by simply washing the plates after silvering. It is best to use distilled water for this purpose, which must be absolutely pure and particularly free from alkaline reaction. We obtain in this manner, after letting them stand for a short time, plates coated with a dry film of yellow iodide of silver, which, when exposed and developed in the manner described below, will yield a picture. It has been noticed that the degree of sensitiveness of such plates is very small, and an exposure four times as long as in the wet process is necessary. The cause of this is the great transparency of the dry plates. A plate saturated with a solution of nitrate of silver absorbs almost all the actinic light which falls upon it, while a washed plate allows a considerable portion to pass through it, which of course is lost for the formation of the picture. It is, therefore, necessary to prepare the plates with a strongly iodized collodion, which, on account of the large quantity of salt contained in it, will form a denser film of iodo-bromide of silver; this absorbs the light more completely; or else the back of the plates should be covered with an opaque pigment. It should

further be observed, that with such washed plates the sensitizer is deficient (*i.e.*, the body which imparts sensitiveness to the slightly sensitive pure iodide of silver), and that from this cause alone the action on iodide of silver is of less intensity. For this purpose it has been tried to replace the wet sensitizer of the silver salts by a dry one. As such, all bodies absorbing iodine can be used. Particularly tannin, gallic acid, and certain resins have been recommended. I distinguish, therefore, amongst dry processes, the tannin, resin, gallic acid, and other processes. With solutions of these sensitizing bodies the washed plates are coated and left to dry. By coating the plates with such a preservative they not only become more sensitive, but also more permanent.

The necessary washing and coating of dry plates with a preservative make the labor somewhat complicated. The development is still more troublesome; the dry plate must first be prepared for receiving the fluids by soaking respectively in water and in a silver solution. The too energetic sulphate of iron developer is apt to give rise to fogs and spots, and the preference is given to the slower acting pyrogallic acid, or a solution of sulphate of iron with the addition of organic substances, which have the peculiarity of retarding the chemical reducing process,—for instance, gelatin.

In a dry process two points are of importance. (1.) The durability. (2.) The sensitiveness of the plates. These are very variable. Many dry processes, for instance, the morphia process, produce sensitive plates, which, however, do not keep long. For long journeys more regard for keeping than sensitiveness should be had. By many preparations the quality of the cotton has a greater influence on the quality of the plates than in the wet process, many even requiring cotton prepared at a high temperature, whose side ingredients have an essential influence. We advise a preliminary albumenizing before collodionizing all dry plates, or at least edging with caoutchouc, or the film may come off, or tear very readily during development. In addition, we advise before developing, to flow the plates with alcohol 80°, then wash; the developer will penetrate the film better.

It is not my purpose here to give a description of all dry processes which have been practiced. So I shall confine myself to the description of two which I have worked successfully.

THE ALBUMEN DRY PROCESS.

The oldest dry process is that of Taupenot; it consists in the employment of an albumen film, which is silvered afterwards. The albuminate of silver takes here the part of the sensitizer.

1. ENGLAND'S COLLODIO-ALBUMEN PROCESS.

This process is a variation of Taupenot's, for which we are indebted to the celebrated landscape photographer, Mr. England, and has been worked with the greatest success by Herr Prümm. It is noted for the durability of the plates. Prümm says: It seems the elements of durability combined in itself, because the preservative is almost wholly removed after it has done its action on the film. For it is certain that a preservative film, left on the plate, protecting it of course for a time from external influences, thereby keeping the plate clean, in a damp atmosphere acts injuriously and quickly on the plate.

The England process depends, briefly stated, on the following manipulation:

I. A bromo-iodized plate is sensitized as usual.

I *a*. The plate is then washed until all greasy lines have disappeared.

II. A solution, consisting of the well-beaten white of eggs, to which has been added a small quantity of distilled water, and 2 to 4 drops of liquid ammonia for each egg used, is poured on the plate, and moved to and fro for about one-quarter to a half minute.

II*a*. The albumenized plate is placed in a second dish of distilled water, and worked pretty freely to and fro to remove all the superfluous albumen. Should one washing not suffice it must be repeated.

III. A thirty-grain solution of nitrate of silver, with a few drops of acetic acid added, serves to change the albumen into silver albuminate, and that is accomplished by pouring it on the plate and moving to and fro for about half a minute.

Should any albumen remain it will show it immediately by a milky precipitate; the next plate must then be washed more carefully, as faults might occur if neglected.

III *a*. The plate is now thoroughly washed under a stream of water, to remove all soluble bodies, and set aside to dry.

The manipulations can be performed more conveniently and quicker in practice than would appear from the above description. If you

have an assistant, you can work hand-in-hand, so that no moment is lost, and in one hour fifteen plates can be prepared, the size of which is of little consequence.

It is advisable to use a collodion made of woolly pyroxylin, it not being required in this process to use short-fibred cotton. Prümm formerly was of a different opinion, and had used for his attempts a powdery cotton prepared at a high temperature. This showed such a considerable structure that he, in adding one part of the bromine to two or three parts of iodine to the ordinary used portrait collodion, obtained perfect and good results. In the preparation the exclusion of all white daylight is essential, the least action of which will produce fogging, therefore, on account of the length of time required for preparing, more care is necessary than in the using of wet plates.

The surplus albumen and silver flowing off the plate can be caught, and, with the addition of fresh solution, used again. In this manner the quantity of albumen and silver used is so small that it would not be worth mentioning.

The drying-closet must be provided with good ventilation; if not, the plates will dry very slowly. The application of chloride of calcium is also advisable, to remove all superfluous dampness out of the air, but will not suffice by itself. *Every interruption in the drying will be an observable defect.*

The plate is in this respect very sensitive; if, for instance, the door of the drying-box is opened before the plates are dry, a dark line will appear afterwards exactly as far as the plate was damp when the interruption took place. Even the circulation of air of a different temperature is sufficient to produce this effect. I emphasize this point, that the plates may be left in the box and not removed too soon. It is not advisable to heat the box before the removal. A temperature of 15—25°+R. will answer the purpose. The drying will take about 8 to 12 hours, when a large quantity is dried at once. Smaller quantities take less time.

In packing the plates, a plate-box with diagonal rabbet is recommended as of some importance (see Fig. 65); in the ordinary rabbet (see first figure), the edge of the film is rubbed off.

In regard to the time of exposure, with dry plates, the most sin is committed. All aim at short exposures, wherein there is no advantage, as it has to be calculated by minutes. Prümm advised on the contrary a long exposure; for instance, if four minutes' exposure is sufficient, expose six; an underexposure will therefore very rarely occur. On the other hand, the *developing is decidedly easier.* Besides this there is another advantage not to be undervalued. In taking a

view with trees during a wind there will be, if the wind is not too strong, at times a lull, which, by repeated repetitions, in long exposure, marks itself sharply, while in a short exposure, which might have occurred during the movement, everything will appear in a confused mass. Should the wind come in puffs, the cap can be placed on the tube until they pass. The same defects resulting from underexposure are obtained by too much haste in developing. This also requires time and patience. All details must have appeared, the green of the trees must show all the gradations, before giving energetic intensifying a thought. Prümm applied to the above the acid developer, namely, at first a very slight addition of citric acid to the pyrogallic acid. The effects were the same as intensifying. Ordinarily the first part of the development is done with clear pyrogallic acid solution, which produced a fog for Prümm, which disappeared on the slightest addition of citric acid. As soon as the first details appear a very small quantity of silver is added. It is of course understood that the plate has been long exposed. In the opposite case no preliminary silver should be used if a good plate is desired.

The developing is a thing of practice, like no other in the whole dry process. Do not fear spoiling a few plates; by this modifying the development you will yourself find the best mode of manipulation, for each plate must be handled differently, and this is what makes this process interesting. Prümm also recommends developing in a small flat dish, for many failures are avoided in this manner without much loss of the solutions used. In regard to the keeping qualities of the plates he thinks that with care they keep a very long time. Prümm kept his for 6 weeks, and developed them 4 or 5 days after the exposure.

2. THE RESIN DRY PLATE PROCESS OF HARNECKER.

A well-cleaned glass plate is coated with common collodion, to which for every 100 grammes (3 oz., 231 gr.) $\frac{1}{10}$th of a gramme of resin ($1\frac{1}{2}$ gr.) is added. When the last drop, after pouring off the excess, has become dry, the plate is dipped in a good working silver bath:

Silver, ...	15 parts.
Water, ...	130 "
Nitric acid, ...	2 drops for every 4 oz. of solution.*

* I give above the original receipt, but believe it would be well to add to the silver bath one-quarter per cent. of the dry salt of iodide of potassium.

The most suitable temperature is 65° Fahrenheit; the time of sensitizing 5, 8, and 10 minutes. The medium time is generally the best. The silver plate is first well washed with filtered distilled water, and next thoroughly washed with ordinary water. Finally it is rinsed with distilled water, and placed on one corner to dry, at a temperature of not less than 70° Fahrenheit nor more than 100°. When dry the plates are ready for use.

The *exposure* is, according to the intensity of the light or the age of the plate, twice or three times that of a wet plate. Fresh plates are much more sensitive than old ones.

The plate is, previous to the development, placed into a dish containing filtered distilled water (it is best to make the water slightly acid). The dish should be moved to and fro, and the plate soaked in it for from five to ten minutes. It is then taken out and placed in the same silver bath in which the plate has been originally sensitized. It is raised and lowered from eight to nine times, and developed like any other wet plate.

The developer consists of:

Sulphate of iron, ...	1 part.
Water, ...	220 parts.
Glacial acetic acid, ...	3 "
Alcohol, ...	4 to 5 parts.

Intensified with the following solutions:

a.	Pyrogallic acid, ...	5 parts.
	Water, ...	2560 "
b.	Nitrate of silver, ...	15 "
	Water, ...	720 "
	Glacial acetic acid, ...	32 "

Fixed with a solution of hyposulphite of soda. The development can also be made by pouring the above iron solution over the soaked plate. It is moved for a few seconds over the plate, poured back into a glass, and then are added two, or at most three, drops of a silver solution, consisting of:

30 parts of silver dissolved in 720 parts of water, and mixed with the following fluid:

30 parts of citric acid dissolved in 720 parts of water.
60 " alcohol.

The picture becomes visible at once, and the plate can be washed after the fluid has been poured over it several times, and the image appears clear and perfect. After washing with ordinary water, the picture is reintensified with pyrogallic acid; but the acid must be

used without the addition of silver in order to avoid fogging. After the pyrogallic acid has been poured off and on several times, citrate of silver is added for intensifying. If care has been taken in the preparation of the plate, not to have the collodion too dry before the plate is dipped in the bath, and it is left immersed sufficiently long, and afterwards well washed, a satisfactory result is certain, particularly when pictures in the *open air* and *landscapes* are taken.

The development can be made at any time after the exposure.

3. RUSSEL'S TANNIN PROCESS.

Russel's tannin process is one of the oldest and easiest working methods, if the precautions are heeded which are mentioned above. Always use albumenized plates for it. The following is the collodion used:

Bromide of cadmium, ...	1 gramme.
Iodide of cadmium, ...	1 gramme.
Dissolved in	
Alcohol, . .	30 grammes, filtered and thinned with 90 grammes of plain collodion of 2 per cent.

The plates are silvered by remaining five minutes in the following bath:

10 grammes nitrate of silver.
100 grammes water.
1–2 drops nitric acid.
4 cubic cent. of a solution of iodide of potassium, 1 : 100.

The plate is rinsed in distilled water, then washed under a tap, again washed with distilled water, then flowed with the following solution:

Tannin, ...	9 grammes, dissolved in
Water, ...	30 grammes, then dried.

In regard to the developing, wash the plate, flow with pyro (the same as in redeveloping); by this a very faint image appears. Let the pyro run into a glass, add a few drops of citrate of silver solution, intensify, and fix as usual.

4. THE BROMO-COLLODION PROCESS.

The bromo-collodion process was discovered by Lea, and is distinguishable from all others, as no iodide of silver is used, no acid, but only alkaline developer; finally, the silver bath is totally put aside

by the use of a silvered collodion. The latter is not absolutely necessary. Bromized collodion containing 2 to 2½ per cent. bromide of cadmium can be silvered in a bath free from iodide of silver. In a bath containing iodide, iodide of silver is precipitated on the bromized plate, and then manipulated as described below. Lately, in England, Wortley improved the process. He prepares bromo-collodion dry plates for the trade as well as the silver collodion (called bromo-silver emulsion).

The bromide process is very simple if too great sensitiveness is not desired. Should this be the case, none of the published formulæ will answer to obtain similarity in the result. As above stated, a cotton prepared at a high temperature is important. The alkaline development, which in this case is of great importance, is an American discovery. Lea is reported to have been the first one to publish it. In this method, instead of using pyrogallic acid with the addition of acid and silver, it is used with the addition of ammonia. The mixture of pyrogallic acid and ammonia reduces the bromide of silver, acted on by the light, thereby causing the picture to appear. The alkaline developer acts very feebly on iodide of silver, therefore it can, in this case, be dispensed with.

A certain opacity of the plates is of importance for this dry process, which is attained by the addition of ammonia or Rochelle salts. 1 part is dissolved in 8 parts of alcohol, and 30 drops added to 30 grammes of bromo-collodion. Wortley adds, besides the above, 2 grammes nitrate of uranium to 30 grammes of collodion. The effect of it is doubtful.

Cooper says the more sensitive the plates the more difficult it is to avoid spots and other inconveniences, and for purposes where it does not necessitate a short exposure, the emulsion plates, with a slight excess of bromide, are the cleanest and surest, and for many purposes, such as architectural views, to be preferred to the more sensitive plates. Wortley, on the contrary, claims that an excess of nitrate of silver is necessary in the emulsion collodion. A solution of caoutchouc in chloroform is used as a preliminary coating, in case a strongly gummed preservative is used; for a less gummy preservative the albumen is the best and cheapest. Without this preliminary coating the plates are easily injured, even destroyed in developing. The gum causes blisters as soon as the collodion is a little tough. Lea has varied his formula many times and improved it. He gives lately the following as the best.

The dry processes known up to the present time divide themselves naturally into two very distinct classes, those like the Taupenot,

Fothergill, English, and other processes, in which the chief constituent of the preservative is albumen, and on the other hand those like the gum gallic, the tea, pyrogallic acid, tannin, and other processes in which no albumen is used. The albumen processes have certain well-marked and excellent characteristics, but they are all slow and require long exposures. Nevertheless it has been found for some years past in England, where dry-plate work is very popular, that a large proportion of the best prints exhibited were made from negatives belonging to the class of albumen preservatives.

On my return to America last summer I commenced a series of experiments to ascertain whether the advantages of these two different systems could not be combined, and whether a satisfactory rapidity could not be imparted to albumen plates, whilst preserving their delicacy and fine modulation. In this attempt I have recently succeeded, even beyond my hopes, and have obtained a process differing in all its essential features from any now in use. It is a collodio-albumen dry process, and yet as rapid as the wet. At the same time, in simplicity and quickness of manipulation, I believe I may say it exceeds all other dry processes.

Before proceeding to the details I may be permitted a few words of explanatory preface.

When in the year 1866 I first took up the study of the emulsion process several formulæ had been published, and some of these called for the presence of silver nitrate in excess of what is needed to decompose the soluble bromides in the collodion. But at that time, the silver nitrate was always added in powder, and much of it did not pass into solution. There was a tendency for the grains of nitrate instead of dissolving to become coated with silver bromide, and then to resist the weak solvent power of the collodion. I introduced the system of dissolving the silver nitrate by heat in a portion of alcohol, and adding this to the bromized collodion and at once agitating violently. In this way *all* of the silver salt was got into solution. and then I found that whenever the silver nitrate was present in excess, *the plates invariably fogged*. After a continued research I found that this could be obviated in two ways, either by the *introduction of a chloride* into the bromide collodion, or by the addition of *aqua regia*. The latter I gave the preference to, and the general experience of photographers during the years that have elapsed since then, has confirmed that opinion. Sometimes, indeed, an advantage is gained by combining both methods.

The behavior of the emulsion made with silver nitrate in solution proved absolutely that up to that time no plate had ever been made

with silver nitrate in excess. The excess had lain at the bottom in powder and inert. Its doing so was all that saved the plates. Had it dissolved, they would have fogged. The addition of a chloride or of aqua regia first rendered it possible to use silver nitrate in excess, and the gain in sensitiveness was immense. At first the extent of the advantage was hardly recognized, but latterly it has been thoroughly appreciated. In describing the action of aqua regia, I stated that any amount of excess of silver nitrate might be employed, but that I found the best results came with a small excess. I regret to say that shortly after a most unexampled attempt was made to appropriate my process on the strength of simply varying the proportion of silver nitrate. By some this variation was held to be an improvement, whilst other photographers found that they succeeded best with my formulæ. Whilst these discordant results in nowise justified the attempted appropriation the fact nevertheless remained unexplained, why such different conclusions should have been come to by different experimenters.

It was not until some time after that I succeeded in solving this enigma. I found that different preservatives required very different proportions of silver nitrate. Up to that time it had been customary to recommend one and the same proportion of silver, no matter what preservative was to follow. This system was essentially wrong, for each different preservative has its definite proportion of silver salts with which it gives its best results. The less sensitive the preservative, the larger the quantity of silver nitrate which it requires.

For a long time I had worked with the cochineal preservative which I had proposed. This is the most sensitive of all preservatives known up to this time; it therefore requires to be worked with a very moderate excess of silver nitrate; if more be used, the plates are found to solarize easily, and if at all overexposed, are found to intensify with great difficulty.

Subsequently I tried pyrogallic acid and got very excellent results. This substance proved to be less sensitive than cochineal, but I found that this inferior sensitiveness could be compensated for by increasing the nitrate, which increase was borne in this case, though it would not have been in the case of the cochineal. By further experiments I succeeded in establishing the general law that I have stated above, viz., that the less sensitive the preservative, the larger the proportion of silver needed for it. So that we have a regular series, cochineal, pyrogallic acid, gallic acid, and tannin, diminishing in sensitiveness from the first to the last, and each member requiring considerably more silver than the next member before it.

As albumen is a preservative considerably less sensitive than any

four just mentioned, less sensitive even than tannin, it is clear that if it be used in the preservative bath, the dose of silver must be very large in order that we may obtain a high degree of sensitiveness, and it also follows that this large dose will be borne without those inconveniences that accompany its use with the more sensitive preservatives. This is to be expected, even if the albumen be mixed with more sensitive preservative agents, for as I have already shown elsewhere, when two preservative agents of different degrees of sensitiveness are mixed, the result will be a degree of sensitiveness intermediate between the two, but rather inclining to be less sensitive.

Applying this principle I succeeded at once in obtaining very sensitive albumen plates, indeed, far more sensitive than any one would have believed that albumen plates could be. It is needless here to give the formula, since it has been superseded by a further improvement which I have just made, and shall now describe, and which is a complete departure from all existing methods both in principle and in practice.

The albumen plates which I first made were prepared in the method usual with emulsion plates. The glasses were edged and then coated with emulsion, plunged into water, and washed till the greasy lines disappeared, then passed into the albumen preservative and dried.

In reflecting over this process, it occurred to me that silver nitrate was so completely precipitated by albumen, that there could be no reason or advantage in this preliminary washing. That, on the contrary, it was probable that a better result would be got by plunging the plate directly into the albumen bath as soon as set.

The importance of this change seemed so great that I first experimented with it in the following manner. An emulsion was taken with a very large excess of silver nitrate, an excess of ten or twelve grains to the ounce. This large excess was to make the trial more decisive, and for the same reason, the plate was coated twice, so as to get a very thick film with a large quantity of silver nitrate. A solution of albumen was prepared, which, to increase the severity of the trial, was made very dilute, one per cent. only of albumen dissolved in water, half a drachm of albumen to six ounces water. Into this the plate was plunged as soon as set. It was taken out when the greasy lines had disappeared and the bath was tested for silver nitrate. *None had been removed from the plate*, and this was also the case (or only the very faintest infinitesimal trace) when the plate had been left in some time longer. All the silver had been converted into silver albuminate *within the film*, so that evidently the previous washing as always hitherto practiced could be dispensed with advantageously,

at least with an albumen preservative, because in this way a larger quantity of organic insoluble silver salt was retained inside the film. The above trial was made by daylight.

Experiment with plates prepared in the dark and exposed in the camera gave the fullest confirmation of the expectations I had formed: in fact the gain was much greater than I had ventured to hope.

So that now I conclude that when albumen is used, *the washing of the plate is just as injurious and unnecessary as would be the washing of an ordinary wet plate before plunging it into the silver bath.* The wet and dry processes are thus brought curiously together, for in both the plate is collodionized, and then simply plunged into a bath, and is then finished. The albumen plate may be either dried or used wet; when wet it is even more sensitive than when dry.

The simplification obtained in this way is sufficiently evident, and the diminished trouble in making the plates, also the difficulty about pure water for the washing. But these considerations are very unimportant compared with the gain to the plate itself. The advantages are:

1. It is much more sensitive. With an equal exposure the development is over in one-fourth the time, and with one-fourth as much ammonia carbonate.

2. The irradiation and blurring are greatly diminished. Small dark objects projected against a bright sky are depicted clean and sharp. Small leafless twigs in deep shadows standing against a bright sky, instead of having an indistinct and blurred effect, come out as sharp as if they had been cut in the film with an engraving tool.

3. There is better detail in the deep shadows, and more variety of half tone.

4. Much less tendency to spots and pinholes.

I shall now proceed to give the formulæ. Besides the introduction of albumen to the emulsion process, and the change respecting the washing, I have found several other improvements which promise to be valuable. I find an advantage in adding *cobalt chloride* to the collodion, and an *alkaline nitrite.* These two changes are of less importance than those previously mentioned. They are not essential and may be omitted, but they have their utility, and I prefer to employ them. Another change of more importance is the following. In processes in which albumen has been used, it has hitherto taken the place of other preservatives. I use it in connection with them, that is, with gallic acid, pyrogallic acid, gum, etc.

Collodion.

Dry cadmium bromide, ...	200 grains.
Ammonium bromide, ...	48 "
Pyroxylin, ...	240 "
Ether, ...	20 fluid ounces.
Alcohol, ...	12 "

To this may be added with advantage:

Cobalt chloride, ...	32 grains.
Potash nitrite, ...	32 "

Potash nitrite dissolves with some difficulty in alcohol. Half the twelve ounces of alcohol should be appropriated to dissolve the nitrite, the other salts to be dissolved in the other half. Keep the collodion in a warm light place for a month. Without the right sort of cotton a total failure will result, or at least only a partial success. The best pyroxylin I have had was made for me.

When it is intended to prepare an emulsion, three or four ounces of collodion is taken, and to each ounce two drops of aqua regia are added. (Aqua regia is easily prepared by adding half an ounce of nitric acid to an ounce of hydrochloric in a stoppered vial, and setting in hot water until the mixture turns orange color.)

The silver nitrate in fine powder is weighed out, taking twenty-three grains to each ounce of collodion (if the cobalt chloride and potash nitrite are used, then twenty-five grains silver nitrate). This is dissolved in alcohol. To do this, take a large test-tube, capable of holding about three ounces, so that the alcohol may occupy but a small space at the bottom, and be in no danger of boiling over. Cover the powdered nitrate with alcohol about an inch deep. Boil over a gas flame, shake, boil again, and after a couple of minutes pour this into the bottle of collodion, and instantly shake well for a couple of minutes. Pour a rather less quantity of alcohol over the residue in the test-tube, and repeat. The third time ought to finish the solution, but if not a fourth may follow. The shaking is *much more* effective if a bottle of such size be selected that it is only about one-third filled. Of course it must be wrapped in opaque yellow paper.

After about ten or twelve hours it will be ready for use. In the middle of this interval it should have one more good shaking. Just before using it should be filtered through sponge, or fine close linen.

The plates should be edged with india-rubber dissolved in benzole, the edging along the sides not quite meeting that at the ends, but leaving an opening for the escape of water under the film. To get an even coat, *pour on plenty, carry it over the plate quickly,* and in rocking,

raise the far end but little, and slowly. These three rules will be found very useful.

As soon as set, plunge directly into the preservative bath.

Preservative Bath.

Water, ...	8 ounces.
Gum and sugar solution, ...	10 drachms.
Prepared albumen, ...	5 "
60-grain solution of gallic acid in alcohol, . .	3 "
60-grain solution of tannin in water, . .	3 "

The tannin may be used or left out. The ingredients must be added in the above order, or a flocky precipitate may be produced which ruins the bath, even if filtered out.

Gum-Sugar Solution.—Dissolve half a pound of good gum arabic and three ounces of white lump sugar in forty-four ounces water. Add one and one-half fluid drachm carbolic acid to make it keep. Shake well, and filter.

Prepared Albumen.—To the whites of five eggs, add an equal bulk of water, and a quarter ounce of acetic acid No. 8. Shake well, and filter through sponge.

Backing.—It is best to back the plates. Take one-quarter pound annatto, three ounces water, one-quarter ounce glycerin, one-half drachm carbolic acid. It will take about two days for the annatto to soften in the water, and mix up to a thick paste to be applied with a brush. If the paste by standing dries too thick for use, add water, but no more glycerin.

Development.—For a whole-size plate, take a 7 x 9 pan, put in four ounces of water and half a drachm of sixty-grain alcoholic solution of pyrogallic acid. Put the plate in (having previously removed the backing by sponging), leave it for a minute, then take it out, and put into the pan one-half drachm of fifteen-grain solution of potassium bromide and half a drachm of eighty-grain solution of flinty (not powdery) ammonium carbonate. If the exposure has been sufficient, this will presently bring up to printing density. If not, add a little more carbonate. If any trouble is experienced in getting density, it is better to redevelop with citric acid and silver, either before or after fixing. If the image is very faint, redevelop as before. But a weak image indicates bad materials or some mismanagement.

Fixing.—Very weak hyposulphite, one ounce to the gallon.

The negatives obtained by this process are not only excellent in quality, but very attractive in appearance, much more so than ordi-

nary dry-plate negatives. In actual practice the process is very easy and pleasant to work.

As regards the numerous other dry processes, such as the tannin, gelatin, coffee, tea, which are always tried over and over again, and always recommended, I must refer the reader to the photographic periodicals, whose province it is to report the progress made in this direction.

To any one who desires to work any of these processes, I must recommend once more the greatest care and cleanliness in the treatment of the preparations. A slight impurity, which in the wet process would perhaps be passed by unnoticed, may cause a perfect failure in the dry process. Many dry plate pictures owe their ill-success solely to the employment of distilled water which was not perfectly pure. But apart from this, the tedious mode of preparing dry plates will frighten a great many. Time is money; and very often the packing and unpacking for an excursion of the necessary apparatus and chemicals of the wet process offers much less difficulty and loss of time than the preparation of a number of dry plates. The dry plate process will only then become practically useful, when such plates can be prepared at not too high a price for the trade, so as to save the photographer the trouble of making them himself.

SECTION II.

PRODUCTION OF TRANSPARENT POSITIVES AND REPRODUCTION OF NEGATIVES.

Transparent positives on glass, also called diapositives, are made with the aid of the negative process in the camera, or by direct printing on prepared glass, the latter being only practicable when the negative is perfectly flat. They are used for window-pictures, magic-lantern slides, or stereoscopic pictures, or for the production of enlarged negatives.

1. TRANSPARENT POSITIVES PRODUCED IN THE CAMERA.

Two cameras are used for this purpose; the fronts are placed to face each other, and from one of the cameras the lens is removed. The objective of the second camera will project into the first camera; the latter serves merely as a proper receptacle for placing the negative and to exclude side-light. The negative, which has already received the necessary retouch, is placed in the plate-holder of the first camera, and kept in position by small pieces of wax, and the plate-

holder is placed in the camera. The whole system is best placed on a long and very solid stand, opposite to a window, with an unobstructed view of the sky.

I generally make such work in the glass-house. The base of the stand is placed in an inclined position, and the light, with the exception of a space ten feet square, is excluded. I place the stand with the cameras opposite this opening.

It is advisable to exclude all superfluous light. When the back of the negative receives light, it will look partially positive, owing to reflection. This of course may give rise to a false effect, and it is better to cover a black cloth over the space where the two cameras are joined together. And the light which passes through the transparent margins of the negative also exercises an injurious influence. The negative acts like a kind of window admitting DIFFUSED light into the camera, and disturbs the clearness of those parts which should remain transparent in the picture which we desire to produce. To obviate this, an opaque mask is placed in front of the negative, in which an opening has been made sufficiently large to illuminate the picture. Window bars and other dark objects in the visual line of the apparatus are disturbing elements; to make them harmless, a piece of fine ground-glass is placed in front of the negative, in order that the light must first pass through the former before reaching the negative. The back shutter of the plate-holder, in which the negative rests, is prevented from shutting by some simple contrivance.

A correct drawing lens of short focus is selected as an objective. Carte de visite lenses of four inches focus, triplets, or aplanatic lenses, answer for this purpose. The bellows of the back camera must of course admit of sufficient extension when a large picture is desired.

Card and triplet objectives should be fastened in a reversed position to the camera (the back lens being front). If we desire, for instance, a picture nine times magnified, we place the apparatus in such a manner that we receive a positive which has been magnified three times; by repeating the operation without changing the position of the apparatus, and substituting the magnified positive in place of the original negative, we will get a picture which is 3×3, or nine times as large as the original negative. It is only necessary to focus once, after which the proper stops can be inserted. The exposure *should not be too long.* The developed positive *should show by transmitted light the same delicate details in light and half tone as a fine paper print taken from the same negative would represent. A fully exposed positive, soft and very sharp, is absolutely necessary for enlargements.*

Very important is keeping clear of the lights in the positives, especi-

ally those intended for magic-lantern slides. The ordinary negatives have nearly always a very fine deposit in the transparent parts. To prevent this, the author adds 5 drops of nitric acid of 1. 2 sp. gr. to 100 cubic centimetres of his collodion. Such collodion will keep only 24 hours. It is not necessary to mix any more than is required. The developing is done with iron, diluted one-half with water.

The beginner must not think that he has succeeded when a clean positive plate has been produced. Before proceeding further, he should examine it very carefully in order to ascertain if it is rich in detail. Sir H. Davy says, expose the positive until it shows a slight precipitate in the bright parts. Intensifying is unnecessary. When a good positive has been obtained, an enlarged negative can be made from it in the same apparatus. Another way is to make a positive on collodio-chloride of silver by the direct process, which will be described afterwards. But aside from *focussing*, which with enlargements requires some patience, the work with the camera is the most convenient.

It is of much advantage to know the equivalent focus of the objective for the purpose of focussing (see directions). If this is known the negative and ground-glass can be placed at about the distance of the equivalent focus, which will save a tedious adjustment. For pictures of original size the distance of the original (negative) as well as the collodion plate, for instance, is about equal to twice the length of the focus. For enlargements the distance of the original is less than twice the focus. Meagher, in London, has constructed a camera with long bellows, which, in the centre of the bellows, has an arrangement for placing the objective, and in the front part of which the negative is easily inserted. All the parts are easily brought nearer or further removed by endless screws, and sharp focussing causes no trouble. Any one who has to work much in this branch will do well to make marks on his camera, which indicate how far the same has to be drawn out for different enlargements.

The avoidance of any shaking of the apparatus during exposure is absolutely necessary. Any, even the slightest motion shows in the enlargement in a heightened measure, and produces a want of sharpness. Care should be taken to have a solid basis, and running about, and opening and shutting doors, etc., must be avoided. Sometimes a vibration is caused by the opening of the objective. I am in the habit of altogether dispensing with a cap, and admit or exclude the light with a small piece of blackened pasteboard, which is placed in front of the negative, and can easily be taken away for the purpose of exposure. *I have still to remark that it is advisable to subject the trans-*

parent positive, which has been obtained in the first operation, to careful retouching before we take a new negative from it. If rightly exposed (which must be found by trial), a very fine detailed transparency can be produced from a very intense negative. If the positives are to be used for window pictures they are toned (after fixing and washing) with a solution, 1 part of chloride of gold, 1000 parts of water. Selle's uranium intensifier also gives a pretty color (1 gramme nitrate of uranium, 1 gramme red prussiate of potash, 200 grammes water).

2. TRANSPARENT POSITIVES PRODUCED IN THE PRINTING-FRAME.

The albumen process is the best adapted for this. We append for this the excellent formula of Edwards, which has been sold in England and America as a secrect. The following solutions are required:

1. A good old red collodion.

2. Albumen: The white of 10 eggs, $7\frac{1}{2}$ grammes water, 30 drops glacial acetic acid; stir thoroughly with a glass rod, leave stand for a few hours, strain through coarse muslin, then filter through cotton or a sponge, add 40 drops ammonia, and $3\frac{3}{4}$ grammes iodide of ammonium, 0.625 grammes bromide of ammonium dissolved in 20 grammes of water. This solution it is said will keep one month if tightly corked, in a cool place.

3. Silver bath: 30 grammes nitrate of silver, 90 grammes glacial acetic acid, 240 grammes water. Iodize the bath before adding the acid; after adding the silver put a small piece of camphor in the bath.

4. Developer: $3\frac{3}{4}$ grammes pyrogallic acid, 600 grammes water, 2 grammes citric acid.

5. Silver solution: 2 parts nitrate of silver, 100 parts of water.

Manipulate as follows: An even plate is coated with No. 1, washed right well, then flowed with No. 2, run off, flow again, repeat for each corner, dry by standing on several thicknesses of filtering-paper, or placing in a horizontal position. The plate must not be moved while drying. The dry plate is dipped in the silver bath and continually moved for forty seconds (not longer), then taken out, washed, flowed with distilled water, then dried. The back is covered with terra sienna; rub up with gum to prevent reflection. The exposure is done in the printing-frame, requiring in clear weather 3 to 15 seconds, according to the density of the negative, which must be learned by experience. After exposure, rinse the plate, heat the solution No. 4 to about 50 per cent. R., flow over the plate, let run back into the glass, add a few drops of No. 5, flow again, moving the plate to and fro. As soon as all the details are visible, wash off by rubbing with a small pad of cotton, continue the developing with

Nos. 4 and 5 until sufficient density has been obtained. Fix in the following solution:

Hyposulphite of soda, 180 grammes; water, 600 grammes; chloride of gold, $\frac{1}{4}$ gramme (dissolved previously in 60 grammes of water). Leave the plate in here about fifteen to twenty minutes; it will first get brown, afterwards black; wash and dry. Varnishing is not necessary.

Besides this process, the collodio-chloride of silver invented by Simpson is used. This, however, is more suitable to positives on white or milk-glass (so-called American porcelain pictures), which produces a wonderful effect. For transparent positives, the chloride of silver positive does not appear strong enough. These pictures are not developed, but gain their intensity by depth in printing alone.

The white of four eggs is beaten to a froth with four ounces of water, left to clear, filtered through a cloth, and spread on well-washed glass plates. The coating is made more even by the aid of a glass rod, and the plates are left to dry in a place free from dust. They will keep for months. In order to prepare them, they are first coated with Collodion No. 1, and after they are dry, with Collodion No. 2 (see chapter on Porcelain Printing); they are dried again and printed in a printing-frame under a negative, which is backed by black cloth. It is easy to control the printing, as the picture becomes visible through the glass. The prints must be vigorous. The plates are washed, toned, and fixed in the same manner as collodion paper (see above), and thus a fine transparency will be obtained which resists mechanical injury without varnish.*

If this operation is repeated, a new negative can easily be made from the positive. For this purpose, however, a very intense print is required, and the best way will be *not to tone at all* a positive prepared with this intention, but to fix it at once, by which it obtains a brown and non-actinic color.

If an enlarged print is desired, the positive is to be treated as stated below.

Monckhoven published a short time ago some extremely important remarks about the reproduction of negatives by means of collodio-chloride of silver. He says:

"I have latterly paid a great deal of attention to the chloride of silver process, and will now give some of my discoveries, which will enable the photographer to successfully produce new negatives.

"I formerly believed that plates prepared with collodio-chloride of

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* This process can of course only be used with flat negatives.

silver ought to be overexposed in order to obtain vigorous results. But I soon found out my error, and at the same time I made a discovery the practical importance of which will be evident to every one.

"The same unforeseen phenomenon of solarization appears with the chloride of silver plates as with the iodide of silver plates, and in such a manner that if a plate of this kind has been exposed too long to the action of light, all the shady parts acquire by reflection the well-known metallic lustre, while by looking through them the red tint will be noticed, in which all the details will gradually disappear. This is the beginning of solarization or overexposure.

"The light acts on chloride of silver (with excess of nitrate of silver) in exactly the same manner as it does under the same conditions on iodide of silver, *i. e.*, *up to a certain point.* When that point has been reached a *retrograde* action sets in.

"I have now tried to avoid the solarization of the chloride of silver plates, or at least to defer it, and I succeeded in this by exposing them to the vapors of ammonia.

"If a chloride of silver plate is cut in halves, *the one exposed to vapors of ammonia*, and both printed under a negative, the difference is very perceptible; the one will be solarized very soon, while the other will give a vigorous picture without the appearance of solarization.

"After these theoretical explanations, I will now state my mode of working.

"I prepare separately the following solutions:

a. Normal collodion—

Gun-cotton,	1 part.
Ether,	32 parts.
Alcohol,	32 "

I let it settle thoroughly, and only use the portion that is entirely clear.

b. Chloride of magnesium,	1 part.
Alcohol,	8 parts.

After the chloride has dissolved, the solution must be filtered.

c. Nitrate of silver in powder,	20 parts.
Distilled water,	30 "
Alcohol,	56 "

The silver is first dissolved in water, the alcohol then added, and finally filtered.

d. Citric acid in powder,	18 parts.
Boiling water,	18 "
Alcohol,	128.6 "

The citric acid is first dissolved in boiling water and the solution filtered after the alcohol has been added.

"For compounding the collodion a brown Rhine wine bottle is taken, for in such it will keep white in open light. It is filled with 600 parts by measure of normal collodion (*a*), and 50 parts by measure of chloride of magnesium solution (*b*). This is well shaken, and 60 parts by measure of silver solution (*c*) added; the bottle is closed and shaken for a few minutes. 40 parts by measure of the citric acid solution (*d*) is now poured in; it is shaken again, and the collodion put away for eight or ten days, for it improves with age.

"I must call the attention of the reader to the fact that he must strictly observe the above-mentioned formulæ, for the preparation of collodio-chloride of silver must be carried on with exactness. If too little silver is present, the collodion is insensitive to light; too much silver produces crystals on the surface of the plate. In the former case silver salt is added; in the latter chloride of magnesium.

"This collodion has an opalescent color. It will not form a precipitate if it has been correctly prepared.

"The plates, after being carefully cleaned, are coated with albumen which has been diluted with its own volume of water; they are then well dried and collodionized. The collodion must be poured on very slowly in order to obtain a thick film. This is much better than to provide the plates with a double film of collodion, as unless this is done with extraordinary skill, the second application of collodion will partially dissolve the first. Before exposing the chloride of silver plates, they are subjected to the vapors of ammonia.

"The ammonia is placed in a watch-crystal, which is placed at the bottom of a box provided with horizontal grooves. The plates are laid three or four inches above the glass containing the ammonia; they are exposed for three minutes to the vapors, left for half an hour in the air, and placed in a printing-frame with the negative.

"Toning and fixing are done according to the directions given above."

n American formula for collodio-chloride of silver.

. . . .	30 grammes.
. . . .	30 "
. . . .	0.625 "
. . . . . .	0.312 "
r calcium, . . .	0.25 "
Nitrate	0.625 "

The diss ents are the same as

above. (For Krippendorf's receipts, see Vogel's *Pocket Reference-book*, page 217. Ost's receipt, see below, Collodion Paper.)

3. REPRODUCTION OF NEGATIVES.

(a.) *By means of the Silver Process.*

The reproducti[illegible] negatives depends on the production of a very fine transparent [illegible]ive which must not have any deposit in the shadows, or show any [illegible]ce of structure or grit. The former chapter contains all the particulars. The process in the camera furnishes a picture, which, by clean workmanship, and right time of exposure, is serviceable to produce [illegible]ood negative. The albumen process furnishes, of course, [illegible] positives. The exposure being in the printing-frame, only flat plates are necessitated. The collodio-chloride of silver positives are not intense enough. The best results are obtained by the dusting-in process.

Having a good positive, the production of a good negative presents no difficulties. If it is to be as large as the original, it can be printed direct from the positive with the albumen process; if, on the contrary, larger or smaller, it is copi[illegible] camera according to the process given on another page, in t[illegible]y manner. The skilful operator, of course, will carefully reto[illegible] positive previous to copying.

(b.) *By means of the Dust or Powder Process of Obernetter.*

Any one who has tried the process of reproducing negatives abovementioned, will observe, that it is a difficult thing to obtain a negative which is *exactly like* the original, possessing the same sharpness, softness, and harmony. Even when we do not take slight variations into account, there has hardly a negative been made which could completely replace the original. The reason is, probably, that for the production of the negative two processes are necess[illegible]
duction of the positive, and next the nega[illegible]
with chloride of silver, or with the came[illegible]
The relation of light and shade becomes d[illegible]
tive, and when we take a negative from [illegible]
will occur, and the consequence is that [illegible]
considerably from the positive.

Obernetter has solved the prob[illegible]itive by employing a process whic[illegible] only, *i. e.*, he makes from a [illegible] pro-

cess of Poitevin. This process was improved by Obernetter and Zeubert, and was formerly employed for making porcelain pictures. A glass plate is coated with a film of gum, grape-sugar, and chromate of potash. This film, when dry, is somewhat sticky, so much so that a pigment powder when dusted over it adheres to it. The action of light destroys this stickiness, and when the film has been exposed under a positive, only the places which have been covered by the opaque parts will retain their stickiness.

If, now, after exposure a powder is dusted over it, it will adhere only to the parts which have *not* been exposed to light, and in this way we obtain a positive from a positive; of course a negative will yield a negative. Obernetter himself has practiced this process for years with the best success, and transmitted lately to the Berlin Photographic Association a number of reproduced negatives, together with the originals. The former were such exact copies that only a skilled eye could detect the difference. Obernetter makes it a business to reproduce negatives, and has, in fact, made excellent work for Loescher & Petsch here. The process is for him of special interest in his "Lichtdruck" establishment, where he has to work with reversed negatives, in order that the resulting pictures may appear in the proper position. Formerly it was customary to detach the film from the glass, and to reverse it, but now Obernetter is, by the abovementioned process, enabled to make a reversed negative, because the reproduced negative is already reversed, and can therefore be used for the "Lichtdruck" directly. When a negative is desired in which the position is not reversed, we pour collodion over the dusted film, and after it has dried we place the plate in water; the film soon becomes detached from the glass, and the film, with the picture, can easily be reversed, and placed on glass.

At first sight it looks as if plate-glass was only suitable for this purpose, but this is not so. Obernetter has copied curved negatives by this process, and it is not at all difficult. He uses mica plates for the purpose, which he coats with the sensitive composition. These conform to the curved plates, and after the picture has been detached it is readily transferred to glass. Obernetter has already reproduced two thousand negatives for the "Lichtdruck" up to a size of two feet. Another advantage is, that by regulating the exposure, we have it in our power to change a hard negative into a soft one, or a weak one into a brilliant one. Obernetter sent me original negatives and copies, and it is a fact, that the reproduced negatives give finer results than the original. The Vienna Society has awarded to the inventor the

golden Voigtlander medal. He has published his method of working, which is as follows:

Dextrin, ...	4 grains.
White sugar, ...	5 "
Bichromate of ammonium, ...	2 "
Water, ...	100 "
Glycerin, ...	2–8 drops.

The above materials, after being dissolved, are filtered, and a newly polished piece of plate-glass is coated with it; the excess is poured off from one corner, and the plate is put aside to dry. If the plate is put into a drying-oven, in which the temperature is from 122–160 degrees Fahr., the film will be dry in from five to ten minutes; the film is exposed under the negative to diffused daylight while still warm. The exposure lasts for about five to fifteen minutes, according to the density of the negative; when the picture becomes faintly visible the exposure is right. After exposure the plate is placed again in the drying-oven until it is a little warmer than the air of the room in which the picture is to be developed. The development should take place in a room not too light. The plate is placed upon a piece of white paper, a brush is placed in powdered plumbago, and the plate is carefully brushed with it; by breathing on the plate it takes the plumbago more readily (the operation is somewhat tedious for the beginner, particularly when the plate has been somewhat overexposed, besides, the plumbago-dust makes one look like a chimney-sweep). When the requisite density has been obtained the plate is dusted off and coated with a plain collodion, containing two per cent. of cotton; when dry a sharp knife is passed around the margin, and the plate is placed in water. The film is, after two or three minutes, easily detached from the plate, and may be reversed and floated on a plate of glass. The plate is washed under a gentle stream of water, in order to remove air-bubbles which possibly may have formed, and finally, solution of gum (2 parts gum to 100 of water) is poured over it, and the plate is left to dry, spontaneously, and in a vertical position.

Obernetter regulates the proportion of glycerin according to the humidity of the atmosphere. When the air is damp and warm no glycerin is necessary, but when the air is cold and dry the addition of glycerin is advantageous. In America, where the air is dry, the addition of glycerin is in most cases to be recommended.

The plumbago plays a very important part. The best is the genuine Siberian, finely precipitated. It is to be had of the celebrated Faber, at Stein, near Nuremberg. Obernetter states that it is easy to guess the time of exposure. Plates which have been exposed too short a

time become veiled, while the result of overexposure is a hard picture. I must remark, that guessing at the time of exposure is a rather risky operation. I have repeatedly made experiments, but always in vain; finally I resorted to the photometer, and succeeded admirably. With thin plates I copied to fifteen degrees; with dense ones to sixteen degrees; and this enables one to be entirely independent of the weather.

W. Woodbury speaks of his experience in reproducing negatives as follows: On my late visit to Germany, I saw Obernetter's reproduced negatives, and these induced me to give the process a trial. I obtained very good results. I did not, however, adhere strictly to the instructions of the formula, *i. e.*, I avoided breathing on the plates as directed, and found that this breathing on the plate was the cause of all failures.* If any one wishes to try the process, I would advise him *not* to breathe on the plate, except in such cases to bring out underexposed parts in the foreground. It is, I believe, impossible to moisten the plate evenly by breathing; much better, if necessary, to place the plate in a damp place.

I used the following solution:

Gum arabic, ...	3.75	grammes.
Grape-sugar, ...	3	"
Glycerin, ...	10	drops.
Acid chromate of potash, ...	1.875	grammes.
Water, ...	60	"

Filter while warm through filtering-paper; keep in a bottle. Cork is unnecessary; keep covered with a piece of glass to exclude dust. A glass plate is washed, dried, and carefully dusted. Every particle of dust will show a black speck in the negative. I cannot say how long the solution will keep; I found it as good in one week after preparation as directly afterwards. But as the solution is easily prepared, it is unnecessary to keep any length of time. One obstacle occurs, when tilting the plate: all the solution flows off without any remaining on the plate, especially when the glass has been cleaned very carefully. If the solution is applied warm, it can be obviated.†

The plate is coated in the usual manner, then carefully dried over a Bunsen burner. A piece of blotting-paper is passed over the lower edge to remove all thickening of the solution there. After the plate is dry and yet warm, place it in contact with the negative in the printing-frame, and expose two to three minutes in the sun.

* In the dry atmosphere of America, breathing on the plates may be necessary, especially in dry weather.

† We avoided this by breathing on the glass.

Take the plate out of the frame, leave it lay about five minutes, pass a soft pencil dipped in graphite over the plate, and distribute it until the desired intensity is obtained. The plate is then coated with a thin plain collodion and dried, after which it is placed in a solution of 1 part C. P. nitric acid and 6 parts water, which dissolves the chromate. When the negative is washed, dried, and varnished, it is finished.

I must give a few special rules. The negative must not be dusted until it is as dense as the original, as it will print too harsh, because the graphite is not as transparent to light as silver. Obernetter's reproduced negatives appear much thinner than the original, printing, however, just as brilliant. The best place for dusting is in the cellar. Freedom from dust in the air is absolutely necessary. It further requires a very fine graphite, similar to that used for coating galvano-plastic forms. It is better to apply larger glass plates than the original negative; there will be no danger then of neglecting the edges while dusting. If you are desirous of reversing the negative, a thicker collodion is necessary.

SECTION III.

THE TRANSFERRING OF PHOTOGRAPHS TO OTHER SURFACES.

At times photographs on ivory, porcelain, opaque glass, wood (for the production of woodcuts), etc., are desired. These are produced with the ordinary collodion process, and the film transferred from the glass, or by application of peculiarly prepared collodion paper, or transfer paper.

1. TRANSFERRING WITH ORDINARY COLLODION.

Every negative or positive on glass, which has no preliminary coating of albumen, can be stripped off the glass, by pouring on the unvarnished film a solution of 1 part of caoutchouc in 100 parts of benzine; after drying, coating with a plain collodion containing two per cent. of cotton and one per cent. castor oil (leather collodion). Throw the plate after drying in water; the film can be removed shortly, commencing at one of the corners. Another manner consists in pouring on warm gelatin solution, 1 : 4, in a horizontal position, and drying. In a few days the film will be ready to come off. If the original collodion is thick, it can be slipped off by immersing in acidulated water (see below). For negatives, the transferring is done merely

to be able to print from the other side, which is of some importance in heliography, photolithography, etc. The mode of transferring on wood is important for xylographs. Grüne does this in the following manner.* A good transparent positive is made in the camera with the ordinary wet process. It is best to use a tough, not overiodized collodion. Any commercial collodion will answer to which has been added 4 to 8 grammes of cotton per pound. After fixing, the plate is left in the water about half an hour—it can remain several hours without injury—and then stripped off the glass. For this purpose the plate is placed in a dish of acidulated water (1 part sulphuric acid to 24 parts of water) for a few minutes; bring it under the tap; the film is then easily washed off into a dish, which must be ready below. The picture is now toned, which in this case is easier than if on the plate. The tone of the picture is of some importance for the xylograph. The color must have a good contrast from the ground, at the same time have depth, and not be too thick and intense. A gold toning bath will answer the purpose, requiring more thinning down than for albumen paper. A solution of permanganate of potash (2 parts in 100 water) is very good, furnishing a brown picture. A chocolate-colored picture is obtained with Selle's intensifier, consisting of a mixture of ferrocyanide of potassium and nitrate or sulphate of uranium. The toned picture is placed in a dish of clean water. It is not exactly hard to work with a detached film; it is more convenient if the dish is rather deep. Take an ordinary camel's-hair brush, pass it under the film, pick it up carefully and place it in the other dish. Should the film fall together, it can be easily smoothed out with the brush. The film is now placed on the block, which, however, must be previously prepared. It is rubbed with zinc white, to which is added a very small quantity of gelatin, just enough to make the color stick without forming a film. When this coloring is dry, the block is exactly in the condition as the artist generally uses it. The film is placed on the block in the following manner. Take a clean glass plate, hold it under the floating film, pick it up so that the film remains upon it. Smooth it out with a camel's-hair pencil. The whole operation is not difficult; care, however, must be taken that the picture-side of the film is on the glass. A piece of semi-transparent paper is wetted and placed on the film, so that it will overlap the paper about one-quarter of an inch, which is turned over. The paper is then, with the film, taken off the glass. The film is now laid on the block, whereby the picture-side of it is towards it; the paper is then removed. As the paper is thin

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* The heads of Apollo, in Part Third, were made in this manner.

and transparent, it is very easy to bring the picture into right position on the block. Any wrinkles or blisters are removed with the camel's-hair brush. A piece of blotting-paper is placed on the film, and gently pressed on the block, at the same time removing all superfluous water. When the film has superficially dried, alcohol is poured on to remove all traces of water. The film is then dissolved by means of alcohol and ether, leaving a brown or black picture, consisting of very fine metallic powder, fast on the block. The dissolving of the film is necessary, as it would split in the engraving. If the negative is taken from nature, it will of course show the tone but not the technicality of a woodcut. Many engravers are in the habit of translating the tones into lines, and find no difficulty in working with tones, but, as a general rule, the sketcher must produce the sketch in lines, which the engraver must engrave accordingly. It would be advisable to give the block containing the photograph to an artist who is accustomed to this work, who can, with a few strokes of a lead-pencil, indicate how the best effect can be obtained.

SECTION IV.

ENLARGEMENTS.

The photographer is often called upon to furnish an enlarged positive from a small negative. This can be accomplished by different methods.

Photographic pictures directly from living models on a large scale can only be made with great difficulty. With a portrait lens of long focus, pictures of one-quarter to one-half life-size can be produced, requiring, however, a long exposure, which not everybody can hold out, the sharpness always in such cases suffering. For this reason large pictures are made in a roundabout way by taking a small negative, enlarging it in an optical manner. The small negative can be taken with a quick, short-focussed lens. On account of the shortness of the focus it will be sharper in all its parts.

Every lens forms a *reduced image* of an object when it is removed further from it than twice the focal length. When an object is nearer to the lens than twice its focal length, the image formed by the lens will be enlarged.

A person five feet high, placed at the distance of twenty feet from a carte de visite lens, will have an image of three inches in height projected on the ground-glass, and *vice versa*, this same lens can pro-

duce a *life-size* picture from the small flat negative at a distance of twenty feet. The brightness of such an enlarged image decreases with the increase of surface, and it is evident that the negative which is placed at the focal distance from the lens must be brilliantly illuminated if we wish to obtain a bright optical image, and this illumination should be the more intense the larger the desired picture is to be.

1. THE INDIRECT PRINTING PROCESS.

This will answer for an enlargement of six to eight times. For this process a transparent positive in the camera is made, or with collodio-chloride, as large as the original negative (see above), and from this an enlarged negative. This enlarged negative can be made in the same manner as the positive on collodion. However, larger plates than three feet cannot be easily made for this reason; it is preferred for medium sizes. It can also be printed with artificial light, and developed on paper, and a positive printed from this (see above). *It must be remarked, however, that the first transparent positive must be carefully retouched before making the subsequent negative.*

2. THE DIRECT COPYING PROCESS.

The enlarged image is projected at once upon *sensitive paper*, and either printed completely or brought out by development. In the latter case a feeble light will suffice; in the former a very intense illumination of the negative is necessary, and this is accomplished by the *rays of the sun*, which either directly, or with the aid of a reflector, fall vertically upon the negative. In both cases the rays are concentrated by the aid of a large condensing lens. *Enlarging apparatus* has been constructed for this purpose.

Dependence upon solar light is generally a great drawback to this kind of work, particularly in northern latitudes, where the rays of the sun possess but feeble power. For such regions the employment of a printing process with development will recommend itself; of course this will not furnish as good results as the direct printing.

In selecting the negatives for enlargement it must be observed that every, even the smallest, fault is magnified, and hence such negatives must be real *ne plus ultras* as regards sharpness, clearness, softness, and purity of the glass. It is customary to employ negatives for the direct copying process which have not been varnished, as the delicate impurities which are suspended in the varnish exercise an injuri-

ous influence, besides the great heat of the concentrated solar rays is apt to soften the varnish.

For moderate enlargements a long camera of large dimensions is sufficient; for larger sizes it is better to use a dark-room which has especially been constructed for this purpose; but unless there is a great demand for these pictures its construction will not pay.

3. ENLARGEMENT BY DEVELOPMENT.

There are two different ways of obtaining a large positive from a small negative. The *direct enlargement*, and the production of a large negative on collodion or paper, which is well retouched and printed in the ordinary manner.

The small negative which is to be enlarged is placed in the apparatus; the enlarged image is projected on sensitized bromo-iodized albumen paper. The exposure in the apparatus requires from fifteen seconds to several minutes, in fact until the feeble outlines of the picture appear. The following bath is necessary:

White of egg, beaten to a froth, and cleared, .	100 parts.
Distilled water, ...	1000 "
Iodide of potassium, ...	15 "
Bromide of potassium, ...	15 "

Or,

Serum, ...	1 ounce.
Iodide of potassium, ...	10 grains.
Bromide of potassium, ...	5 "

The paper is floated on this bath for three minutes, dried, and preserved in a closed portfolio.

For sensitizing it is floated for three minutes on the following silver bath:

Distilled water, ...	1000 parts.
Nitrate of silver, ...	70 "
Glacial acetic acid, ...	70 "

While still moist, the paper is dipped in a bath of:

Distilled water, ...	1000 parts.
Citric acid, ...	4 "
Pyrogallic acid, ...	2 "

The picture develops in a few minutes; it is then placed in a bath of hyposulphite of gold, and left in it for five minutes, and washed.

The composition of the fixing bath is:

Water, ...	1000 parts.
Hyposulphite of soda, ...	100 "
Chloride of gold, ...	½ "

Generally speaking enlarged pictures are inferior in beauty to those which have been taken directly. In America I have seen the best solar enlargements.

The whey process is very well adapted to enlargements by developing. The paper is immersed in

Iodide of potassium, ...	2 grammes.
Bromide of potassium, ...	1 gramme.
Filtered whey, ...	100 grammes.

Then dried. It will keep for some time. Before using it is sensitized on a bath of

Nitrate of silver, . . .	30 grammes (in winter 40).
Water, ...	500 "
Glacial acetic acid, . .	2 to 10 grammes, according to temperature, or inclination to fog.

Spread it out damp and expose. The time of exposing, in the solar camera, is fifteen seconds to one minute, according to the intensity of the negative.

Developer.

Pyro, ...	3 grammes.
Glacial acetic acid, ...	150 "
Water, ...	1000 "
Bromide of potassium, . . .	1 to 2 "

The picture is developed by placing it on a glass plate, and pouring on the solution. To prevent too strong development, pour on a solution of salt afterwards.

THE CARBON PRINTING PROCESS.

To the description of the silver printing process we will add the process for making carbon, or rather pigment pictures.

They have only recently been made in large quantities. As regards their ability to resist chemical influences, and also the choice of color (the maker can give to the gelatin film, which is the foundation of the picture, any color he chooses to take) they offer considerable advantages over the silver prints, which advantages would perhaps make themselves still more felt, if the process was less complicated.

The principle of the process consists in the following: Glue or gelatin mixed with chromate of potash is soluble in hot water; exposed to the light it becomes insoluble. If a chromatized film of glue or gelatin is exposed under a negative, those parts through which the light passes, *i. e.*, the shadows, will become insoluble, and the deeper the

longer the action of the light is continued. If this is plunged in water, all the parts which were not exposed to the light will dissolve, and all the parts exposed to the light will remain, giving a picture of the color which has been mixed with the gelatin. Generally, the surface only becomes insoluble, and the part underneath remains soluble. If such a film is dipped in water, the lower part is dissolved, and the upper part containing the picture swims away. To prevent this, the film must be transferred before dipping in water to develop; as this reverses the picture it must be retransferred after developing.

Pigment paper is the material upon which the prints are made. It is a paper coated with colored gelatin, and can be bought of the stockdealers; two kinds are mostly used, the so-called *purple black* and purple brown. It should be kept in a place which is neither damp nor too dry. In a very dry place the *gelatin film is apt to break.*

Sensitizing the Paper.—The sheet which is to be sensitized is placed upon a glass plate, and the printing surface is gently rubbed with a soft clean linen cloth. Touching the paper with the hands or fingers should be avoided as much as possible.* After being cleaned it is seized by two corners, and dipped into the sensitizing solution, and by drawing it through it it is skilfully turned and left in it for three or four minutes with the printing surface uppermost. This must be done by *lamplight.* The sensitizing solution consists of—

30 parts bichromate of potash.
900 parts cold water.

The solution will not keep for a long time, and it is best not to make more than what is necessary for immediate use. For a sheet of pigment paper about 250 cubic centimetres of solution are necessary. The solution is thrown away after being used. The necessary temperature is about 66° Fahr. Two pieces of paper can be placed at once into the solution, but they must be kept separated. When deep boxes are used the paper can be placed in them vertically, and a larger number can be sensitized at once, but they must be kept about one-half of an inch apart. When the paper has been taken out of the bath it is hung up to dry, by fastening two corners to strings stretched in the dark-room. The drying temperature must not exceed 78° Fahr.; when it is higher the gelatin is apt to run off. In this case it would be better to place the sheets on nearly horizontal boards. The drying requires from six to twelve hours. Paper which has been sensitized in the evening is ready for printing the next morn-

* With fresh clean sheets the rubbing is unnecessary.

ing. In dry weather the paper will keep for several days, in damp weather only twenty-four hours. It is best to place the sensitized paper into a book with a weight on it; it must, of course, be kept in the dark, for sensitized pigment paper is four times more sensitive than ordinary silvered paper.

Exposure of the Paper.—To make a print, the perfectly dry paper is placed with the negative into the printing-frame, always, of course, by lamplight.

The exposure was formerly the most difficult part, but the introduction of the photometer has surmounted this difficulty, and made it even more simple than the silver process, as not all the frames, but only the photometer, has to be examined. A person not experienced in the use of the photometer will do well to make some trials with it before printing a picture (see remarks thereon).

Developing.—The paper which has been exposed shows no trace of a picture. It looks black as before. The picture appears as soon as it is dipped in hot water. If this was immediately attempted, a picture without half-tones would be the result. For this reason the film must be transferred from its original support (paper) to another surface, glass or metal, so that the invisible picture on the surface is completely lifted off, and the superfluous gelatin removed from the back. If the picture remains on this new surface, it will appear reversed; transferring again will bring it to its original position. If it is wished to have the picture appear glossy, a glass or smooth zinc plate is rubbed with the following solution:

Gum dammar, ...	1 gramme.
Benzine, ...	40 grammes.

If a more gritty surface is desired, take a ground-glass, zinc, or porcelain plate, and rub it. Instead of the abovementioned varnish for the same purpose, a mixture of beeswax and resin, equal parts, dissolve 11 grammes in 600 cubic centimetres of turpentine. Take off the surplus poured on with a clean rag, so that the surface will not appear smeary. If a pliable support is desired, rub the above solution on shellac paper, such as is sold by the Autotype Company of London.

This varnishing is only necessary when the picture is to be retransferred. If it is to remain on the original support, very often no varnish is needed. On many kinds of glass, namely, opaque or milk-glass, the film holds well, and such a pigment print upon it looks wonderful, the main object being to have the plate clean and free from grease. If the film does not hold by itself, the varnish

must be applied, which serves afterwards for the transferring described below. The exposed sheet is now placed in cold water, and will roll directly inwards; then get flat, and finally roll outwards. As soon as it is flat it is taken out, and immediately *pressed* on the prepared surface; dip this under water, and squeeze the remaining air-bubbles out. The best way to proceed is this: The prepared surface (glass or zinc) is laid on a flat, level table, water poured on, the sheet is taken out of the tank wherein it was soaked, holding it by two opposite ends, laying the middle down first, letting the ends down gradually, driving thereby all the remaining water out. A piece of gum fastened between two pieces of wood is used to rub the remaining air-bubbles out. A little care must here be exercised, as they will not disappear by themselves. The plate with the pigment paper is now set aside for five or ten minutes; it is then dipped in a tank of water of about 25° R. In a short time the paper will come off, and the gelatin dissolve out. The paper is taken away, and then let the picture develop. If it is transferred on paper it is best to turn the picture-side down. The water in the tank had best be kept warm by a lamp. When the picture is fully developed, rinse it off with cold water. The process must not be forced too much, especially do not use the water too hot at the commencement, as the film will suddenly expand, and become full of wrinkles. Beginners must also be careful not to let the sheet expand before placing on the zinc plate, and not to develop too soon after transferring. If the picture is overexposed, use finally hot water, but let it get so by degrees. When the picture is washed, it is made insoluble with chrome alum solution.

The Transferring.—In transferring the developed picture the following papers will answer. The transferring paper of the London Autotype Company, or a paper prepared with the following:

Gelatin, ...	24 grammes.
Chrome alum, ...	0.8 "
Water, ...	576 "
Glacial acetic acid, ...	12 "

The gelatin and alum are dissolved separately, are then mixed, and the acid added which will keep the solution durable. This paper is soaked in water of 32° R., the developed picture is moistened, and brought under water in contact with it. The superfluous water is removed by squeezing with the gum, then letting it dry. The paper will come off the picture. The transfer paper of the Autotype Company is better than the above receipt. It is well to dip the finished picture in a chrome alum solution of 1 to 200, and dry. It is pleasanter to

obviate the second transferring altogether, and to develop the picture on the original surface. Pigment prints transferred on toned paper, the high-lights of which have been touched with Chinese white, have a very nice effect. By transferring to gritty or rough-surface paper, charming effects are produced, which are impossible in the ordinary way of printing. Finished pigment prints can be colored very well with water colors. If it is desirable to color heavy, the picture is prepared with a watery solution of shellac which hardens the gelatin. Too dark parts can be made lighter by erasing.

Printing on Ivory.—Pictures can be transferred directly on ivory and developed, and this is recommended instead of the second transferring. With gelatin, of course, the chrome salt colors the ivory yellow, which can be avoided by washing the picture, thereby removing the salt, leaving it dry, and proceed as above. It is well to roughen the ivory previously with a piece of pumice-stone.

Reversed Negatives.—To avoid the second transferring reversed negatives must be used. It is best to place the plates reversed in the camera; of course, the focus must be adjusted to the thickness of the plate used. Prisms can also be used to reverse the pictures.

PIGMENT PRINTS ON ALBUMEN PAPER

Can be produced on coagulated albumen paper very easily. Grasshoff and Jeanrenaud coagulate their albumen paper themselves, by immersing it in strong alcohol for a few minutes, and drying. It is self-evident that in this manner a very cheap article can be turned into money. The damp coagulated albumen paper is placed on a plate, the albumen-side up. Bring the exposed pigment paper, which has been soaked in cold water, on it, and press it on well to remove all air. The pictures are laid in a press for about one hour, and finally dipped in hot water to part the two sheets. The pictures now stick to the albumen. They are then at once placed in lukewarm water, and fully developed. The development must be done by lamplight. The dried pictures are tanned, washed, and finished as usual. Jeanrenaud remarks that alcohol dissolves the resinous sizing of the paper. Marbled stains are then formed on the transfer paper, and if operated after transferring into hot water, blisters appear on the picture. Jeanrenaud obviated this difficulty in a simple manner. The exposed pigment sheet is placed in a pack of blotting-paper which is slightly damp. While the sheet is here getting pliable, dip the albumen paper in a cylindrical-shaped glass which is filled with strong alcohol, draw it out almost immediately, and bring the alcohol-dripping

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sheet on a glass plate, albumen-side up. Now take the pigment paper, which in the meantime has become pliable, lay it on the albumen paper, and press it on by means of a leather roller; press it thoroughly for a few moments in a press, and develop with hot water. This method has several advantages: saving of alcohol which is used up to the last drop; ease, as the albumen paper can be prepared the moment it is wanted; avoidance of blisters, even when boiling water is used; saving of time. If the sheets are properly moistened with water, it will answer to put them together, press them, and develop them immediately.

One inconvenience occurs by transferring on paper, namely, the forming of blisters during development. These are caused by air, penetration of air through the back of the albumen paper. Vidal therefore recommends vegetable paper soaked in alcohol instead of albumen paper, which is impervious to air. He immerses the vegetable paper for fifteen minutes in an alcoholic shellac solution containing 12 per cent. shellac, then hangs it up with paper pins to dry. The pigment print is fastened in a similar manner as on a zinc or glass plate, and afterwards developed in warm water. The picture is afterwards treated with alum. It can be transferred from the shellac paper to a second. For this purpose the picture is coated (lying on a glass plate) with a warm gelatin solution (containing 15 per cent. gelatin), but none must touch the back, then dry the whole. Afterwards the sheet to hold the picture is slightly moistened, dried with blotting-paper, and laid on the film; all traces of blisters removed, afterwards carefully rolled and dried. Finally, throw it in an alcohol bath, allowing it to remain for one hour. The shellac sheet will soften, and can be removed with a penknife, the picture remaining on the second sheet, in the original position.

THE USE OF DR. VOGEL'S PHOTOMETER.

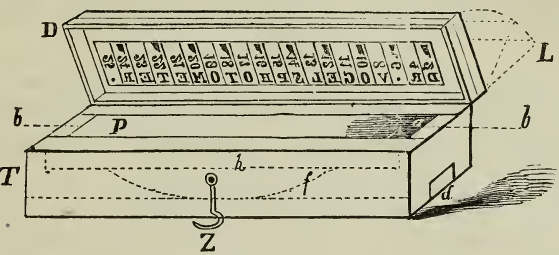
This instrument consists mainly (1) of a *semi-transparent paper scale;* the transparency of this scale decreases gradually from one end to the other; (2) of a sensitive chromate paper, which will retain its sensitiveness for weeks. The paper is exposed under the scale in a similar manner as a piece of silvered paper is exposed under a negative.

The chromate paper is made by dipping plain photographic paper in a solution of one part of red chromate of potassium to thirty parts of water; when dried it is ready for use.

The dry paper is cut into strips of suitable size, and the photometer

box, *T*, is filled with them. When the lid, *D*, of the box is closed, a spring, *f*, presses the strips against the transparent scale. The scale is

Fig. 75.



fastened to the glass lid, *D*, and can be held in contact with the box, *T*, by the hook, *Z*.

When the apparatus is exposed the light will pass through the scale and darken the strip of paper underneath it. This darkening progresses from the most transparent to the least transparent end of the scale, and the progress increases in rapidity with the increase of the intensity of the light.

On the scale black numbers are painted, in order to ascertain how far the action of the light has extended. The opaque numbers do not permit the light to pass through them; the chromate paper, which gets darkened around them, will show a white number on a brown ground.

When the photometer is now examined by lamplight it will be easy to ascertain (by examining the strip of chromate paper) *how far the action of the light has extended, as the last visible number on the chromate paper will indicate it.*

To ascertain the proper printing time of a negative we must proceed in the following manner: A plate containing, for instance, four cartes de visite negatives is exposed to the light simultaneously with the photometer; when the instrument has, for example, reached the number 10, one of the four pictures is covered with a piece of black paper, which is placed between the negative and the pigment paper; the same operation is repeated when the number 12 has impressed itself on the chromate paper, and so on when it has reached 14 and 16; in this manner the different pictures have been respectively printed to 10, 12, 14, 16.

The picture is developed and examined to see which part shows the proper intensity. The degree of the photometer, for this part of the picture, is the proper degree for the whole negative.

Sometimes the proper printing degree lies between two of the numbers employed, for instance at 13 or 15; when this is the case the picture marked 12 will be a little too light, while 14 is a little too dark; if all the pictures are either over or under printed, the experiment has to be repeated again with respectively higher or lower numbers.

With large pictures, landscapes, etc., a similar experiment as with a carte de visite negative is made by covering successively parts of the landscape, taking care, however, that characteristic parts—bright lights and dark shadows—occur in every part.

A *number* of negatives are arranged according to their density; the practical photographer will easily classify them by looking through them; they are assorted in three classes—weak, medium-dense, and dense; the photometer degree for each class is determined by actual experiment, and all the pictures are printed according to the result.

A new negative is closely examined with the eye, and compared with a negative the printing degree of which is known, and the printing time is regulated accordingly.

When a negative should offer difficulties in determining its density, an experiment is easily made; a characteristic part of the picture, under which a strip of sensitive paper has been placed, is exposed to the light simultaneously with the photometer; the strip is gradually covered, when the photometer has respectively shown the numbers 10, 12, and 14; the strip is then transferred and developed, and examined, in order to see which part has been exposed the proper length of time.

After a few experiments of this kind, and after working for a short time with the photometer and the pigment printing process, the eye becomes so well trained that a glance at the negative is sufficient to indicate the necessary photometer degree.

For the purpose of printing on a larger scale the following method is the most practical: All the printing-frames which one intends to use are filled in the dark-room with paper; they are exposed to the sunlight simultaneously with the photometer; when this instrument indicates the printing degree of the weak negatives, the latter are taken up and carried into the dark-room, or they are reversed and covered up; and so on with the medium-dense ones and the dense ones. The whole operation will in *fine weather* only take a few minutes. The photometer must be watched very closely, in order to arrest the printing process at the very moment when it has progressed far enough. When all the frames have been taken into the dark-room they are refilled with fresh paper, and the process begins anew.

When the saving of time is an object, and where not a minute is to be lost, three photometers, one for each class of negatives, should be employed.

The next thing to be taken into account is the sensitiveness of the pigment paper; American paper, for instance, is twice as sensitive as English paper.

When the photographer receives a paper the sensitiveness of which differs from that with which the photometer degrees have been determined for his negatives, a new experiment becomes necessary, and the result—the difference in sensitiveness expressed in photometer degrees—can easily be added to or deducted from the negatives, as the case may be.

By a single trial (as described above) the degree of a *single negative* is determined for the new paper. When for the old paper the degree of a negative is, for instance, 12, and for the new paper, say 14, it only remains to add simply the difference, $14-12=2$, to all the known degrees of the old negatives, and they will by this simple process be correctly timed for the new paper.

When the new paper has a lower degree, 10, for instance, then the difference, 12—10, is deducted from all the known degrees.

The photometer paper is prepared in the following manner:

A sheet of plain Rives or Steinbach paper is cut up into eight equal parts, and immersed by lamplight for three minutes in a solution of

1 part of bichromate of potash,
30 parts of water.

It is the same solution with which the pigment paper is sensitized. The strips are completely immersed, and hung up to dry.

Paper prepared in this manner, kept in dry, clean wooden boxes, from which the light is excluded, will keep for *at least four weeks* without change.

The photometer paper should be made before the pigment paper is sensitized in the liquid; after it has served for the latter purpose, it is no longer fit for the photometer.

The paper is cut into strips of suitable size to fit into the photometer box; the *fingers should be perfectly dry* while handling it. The first and last strips are thrown away. The strips are laid one by one into the open photometer box; the press board is placed in position, and the lid is closed with the spring. The upper glass lid is now opened, by lamplight, in order to ascertain if everything is smooth and even. The papers must be firmly pressed between the strips of tin. When everything is not smooth and even, it is easy to make it so by means

of a piece of white paper, which is introduced from the glass lid, and smoothed with the finger. All this must of course be done by lamp-light.

When everything is in proper order the box is closed and hooked.

So prepared, the photometer with the lid closed is placed in position *simultaneously with the covered printing-frames;* next the cover is removed from the frames, the lid of the photometer is opened, and the exposure begins. After a short time, say from one to five minutes, according to the weather, the frames are covered again, the lid of the photometer is closed, and the latter is carried into the dark-room, where a lamp is burning.

The instrument is here opened and examined, in order to see which figures have appeared. No. 2 appears first, bright on a brown ground, next 4, then 6, etc.; the higher figures of course much paler. In order to ascertain how far the action of the light has progressed, it is necessary to protect the eyes against bright light.

The open instrument is held below or at the side of a bright flame, at about the distance of eighteen inches, in such a manner that the rays fall vertically upon the yellow paper. With the eye protected against the light, we glance over the paper (in the direction of the figures from 2 to 25). When held in this position it is easy to discern the figures. But not only should the attention be directed to the figures, but also to the index hands and letters, as they materially facilitate the recognition of the slightest light effect on the paper. Turning the instrument gently from side to side will soon enable one to ascertain the most advantageous position.

After a few experiments the necessary expertness is readily acquired.

It must be observed that when one steps from a light room into a dark one, that at first nothing will be noticed, but the eye soon accommodates itself to the dim light, and we are able to recognize all the details.

Similar things occur when we try to read the photometer, and when the eyes are dazzled by bright light.

When the observation is over, the photometer is returned to its place amongst the printing-frames; the lid is opened, the frames are uncovered, and the exposure is continued. After one or more minutes, the photometer is carried back into the dark-room and re-examined, having previously covered the frames, observing all the precautions enumerated above. When the desired degree has not been reached, the exposure is continued. The time which has so far elapsed, and the figures which have been observed, serve as a guide for calculating how much more time may be necessary to finish the print.

Exceeding the number by a single degree does not amount to much, as the error is easily remedied by longer development. Under-exposure is worse.

When we have negatives of different degrees, we have first to remove those of lower degree, or we may cover them up, and continue the exposure of the balance until their proper degrees have successively been reached.

When all the prints have been made, the frames are carried into the dark-room; the frames are supplied with fresh paper, and the upper yellow colored strip is taken from the photometer *by pressing upon it with the thumb of the left hand;* this lowers the spring lid; both ends of the strip are now pulled from under the tins; the remaining strips are smoothed down, and after closing the instrument, it is ready for another exposure. The upper yellow strip is thrown away.

Photometer observations require the same qualities which every silver printer should have when he wants to make silver prints:

1. An eye which can discern slight light effects.
2. Care in regard to the photometer paper. The latter is more sensitive than silvered paper, and should be treated with the same cleanliness; it must not be exposed to bright daylight. Particularly in clear weather great care is necessary.

If, through carelessness, the paper becomes affected by daylight, it loses part of its sensitiveness. We must also remark that in the lower degrees the instrument rises very rapidly; in the higher ones much slower.

It is further to be observed that the paper scale must be firmly pressed against the yellow strip, as much so as the silvered paper has to be firmly pressed against the negative.

The paper scale must not be touched with the fingers, and must be kept dry. The glass should always be cleaned previous to using the instrument.

I mention the following degrees, for a negative of medium density, as determined by trial, for different kinds of pigment paper:

Paper by Swan (brown-black), ...	15 degrees.
" Rowell (gray-black), ...	11 "
" Beyrich (purple-black), ...	12 "
" Beyrich (purple-brown), ...	16 "

SECTION V.

FERROTYPES.

Instead of the ceremonious negative and positive process, the Americans often make use of the ferrotype process, which produces a positive picture direct in the camera. If a negative is held against a dark background it will appear positive. The shadows are formed by the dark background which is visible at the transparent parts, the lights by the silver which covers them. In an ordinary negative the lights are covered too heavily, showing therefore no detail. If, however, a negative is under-exposed, a glass picture is obtained which on black paper has a very good positive effect. Such pictures can be made on an asphalted iron plate, which itself furnishes a dark ground. Such iron plates are collodionized, silvered, exposed a little short, developed, fixed, and varnished, furnishing in a short time a positive picture, which of course shows the right left, and the left at the right, and *vice versa*. The chemicals necessary to this process do not materially differ from the negative process. For a silver bath a negative bath with a few more drops of nitric acid per pint will answer. For collodion, one with considerably less salt and cotton than in the negative process is used. Trask, in his excellent "Practical Ferrotyper," recommends:

Bromide of potassium,	20 grains.
Bromide of cadmium,	30 "
Iodide of ammonium,	100 "
Ether and alcohol,	10 ounces.

Gun-cotton 4½ to 5 grains per ounce.

Any freshly prepared developer is to be recommended. For fixing, use cyanide of potassium; it makes the shadows clearer.

As full instructions with formulæ for making ferrotypes are given in the *Ferrotyper's Guide*, I must refer my readers to its pages for further information.

CHAPTER VII.

PRACTICAL APPLICATION OF PHOTOGRAPHY.

In the previous part of my work, I have explained the operations which are necessary for the production of a negative or positive picture by means of light, without reference to the nature of the object to be taken.

Any one who will follow exactly the directions given, may take whatever object he pleases, and will always get a picture, but very seldom a perfect one. Even the beginner will soon find out that the nature of the object has a great deal to do with success, and that this should not be overlooked when we wish to obtain a satisfactory result.

Let us attempt to copy an oil painting, or a copperplate print, with an exposure which would be sufficient for a portrait, or the reverse; let us apply the intensification which is necessary for such reproductions to a portrait, or let us copy a large drawing with an illumination suitable for a portrait. In either case we will be horrified at the result.

The nature and the succession of the operations remain generally speaking the same, and still every one of them, *pose, illumination, selection of the model, sharp focussing, time of exposure, development, intensification*, must in some measure be modified according to the nature of the object to be taken, and unless we pay strict attention to these circumstances the resulting picture will not be satisfactory.

It is erroneous to think that photography always draws truly. Nothing can be less true than a photograph, when it has been made under circumstances which are not suitable for the object. (See chapter on Æsthetics.)

We must therefore go a little more into detail concerning photographic operations as applied to different objects.

The field is endless. Sun, moon, and stars, animals, plants, minerals, products of art and products of nature, the microcosmus and the macrocosmus, all, all belong to the realm of photography. So I am excusable when from the multitude of things I only make a selection. To treat of all exceeds the limit of our work.

I will select those objects the representation of which is principally

the work of the practical photographer,—drawings, paintings, models, machinery, architectural objects, landscapes, and portraits.

I will speak first of the more mechanical work of "reproductive photography" and the copying of technical objects, and I will reserve the consideration of portrait and landscape photography, which is more of an artistic character, for the second part of my work.

SECTION I.

PHOTOGRAPHIC REPRODUCTIONS.

(*Copying of drawings, prints, oil paintings, etc., etc.*)

1. PREPARATION OF THE ORIGINAL.

Care should be taken to get a clean original. A drawing with dirty finger-marks will yield a dirty negative. Lead-pencil lines in india-ink drawings are also annoying, and unequal color of india-ink is objectionable. Photography reproduces everything, the most trifling thing, and the latter very often in an unpleasant degree. Drawings and prints should first be rolled in the press, to do away with the inequalities of the paper. Pictures which are framed under glass should be taken out of the frames, as the glass is apt to produce disturbing reflections of light.

It is well known how much difficulty some yellow prints or spotted drawings will cause. To overcome this, we should resort to retouching the original. Mr. Scamoni, photographer in the Imperial printing establishment, at St. Petersburg, writes about it as follows: Every yellowish or otherwise disturbing spot is carefully covered in the spaces between the lines with flake white, and the shadows are, wherever it is possible, intensified. When the paper is rumpled and not smooth, it should be firmly pressed in a frame against a piece of plate-glass, through which, when it is carefully placed, and with a steady light, very good photographs can be taken. *That the object be absolutely* PLANE *is always necessary, otherwise the picture will show distortion.*

2. ARRANGEMENT.

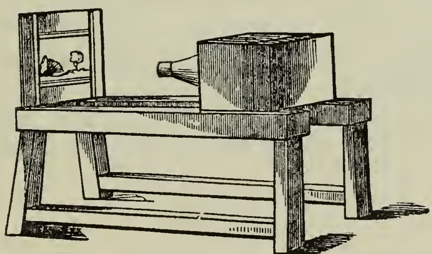
The reproduction of drawings is the simplest of photographic work. Elaborate arrangements are unnecessary. Perfectly smooth stretching on the drawing-board, perfect parallelism between the board, the ground-glass, and the apparatus, are the principal conditions of success. When these conditions are not observed, distortions in the drawing will necessarily be the consequence. The lines, which are

parallel amongst themselves, converge towards the top or the sides, when the apparatus, instead of being absolutely vertical to the axis of the drawing, is turned a little upwards, or downwards, or sideways.

To secure this parallelism in the position, larger establishments have made arrangements to keep drawing-boards and apparatus always parallel to one another.

Such an apparatus (Fig. 76) consists of a strong support, which rests lengthways on four or more feet. On one end the drawing-board

Fig. 76.



is attached at right angles to the metal guides, which are fastened to the sides of the support, and along which the camera moves. When necessary, one end can be left open to admit the operator for the purpose of focussing, and the support can be made rigid by uniting the feet near the floor, and strengthening the guides on which the camera moves, by iron braces. On the copying-table in the Royal Technical Institute, in Berlin, the drawing-board is moved by cords, which run over rollers underneath the camera.

The drawing-board should be divided into square inches, which, combined with the square inches which are marked on the ground-glass, will be a great help in determining whether the picture is exactly square and of the right shape, and it affords at the same time a means for determining the proportion, whether $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{4}$. It is also very practical to provide this apparatus with a scale at the sides divided into inches, by which the distance between the drawing lens and ground-glass can be determined beforehand. The distance (with a given lens) necessary for making a natural size, double natural size, or half size picture, can be marked down once and forever, and all the trouble of finding out the position is avoided in the future.

The dimensions of these supports must necessarily depend on the extent of business of the atelier. It must be observed that for natural size drawings, the ground-glass must be removed from the lens the distance of twice its focal length. Smaller supports of this kind

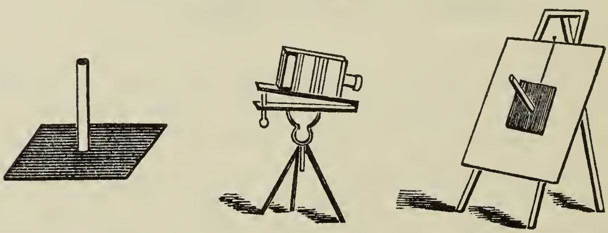
should be placed on rollers, as it facilitates their removal from place to place.

In an atelier where reproductions are an exception, simpler arrangements will answer every purpose.

In this case the drawing is simply placed on a stand as before described, and the camera is placed opposite. The distance necessary for getting the correct size of the picture is first found approximately; next the board and camera are placed as nearly *vertical* as possible by placing the sides exactly parallel with some vertical architectural part, as, for instance, the corner of a room; finally, to get the camera and board parallel to one another, the lines of the boards of the floor will serve as guides. It requires some patience, but the result is better than with a spirit-level.

A very simple method to place the camera and copying-board parallel, consists in using a black board with a white stick fastened to

Fig. 77.



it perpendicularly. This is fastened on the copying-board; point your camera towards it and focus; if the stick appears as a white circle on the ground-glass, the camera and board are parallel.

With oil paintings a different course has to be taken; to avoid glaring reflections, they have to be inclined forward in the same way as they are generally hung on the walls of galleries.

3. ILLUMINATION.

For copying drawings, the illumination is of the simplest kind; nothing is necessary but an even light over the whole surface. This takes place only when the angle of light is nearly the same for every point of the picture. Any one who has studied the principles of illumination, as laid down previously, will easily satisfy himself on this point. A front light, which passes over the camera on to the drawing, is the best. Care should be taken that the camera does not throw its shadow on the drawing.

Sometimes the paper is rough; each fibre or each depression will cause a shadow. When this is the case, the drawing should, if possible, be passed through the rolling press, or else a sheet of white paper should be laid in front of it and used as a reflector.

More annoying than unevenness is gloss, as with varnished pictures, and particularly oil paintings and photographs. The easel with the picture should be placed where this disturbing reflection does not appear. Opening and closing the curtains sometimes gives material advantages. To be quite sure that it does not disturb, the eye should be placed in front of the lens and the picture examined. This will show the exact effect of illumination. Oil paintings are placed at an angle, as stated above; the axis of the apparatus is placed vertical to the surface. Sometimes direct sunlight is of advantage, particularly when age has darkened the picture. The illumination should be so arranged that, besides the gloss, the shadows of heavy layers of paint are avoided.

4. THE LENS.

All kinds of lenses are used for reproductions. With art subjects, copperplate prints, oil paintings, a slight distortion does not matter much, particularly when only the central part is used. For mathematically correct pictures, however, an absolutely correct drawing lens is required, and as such a one I recommend the Steinheil Aplanatic Lens, or the Ross Doublet.

Portrait lenses which have a great deal of light are only necessary for dark oil paintings, to shorten the time of exposure. Objectives of feeble light, as the Pantoscope (which also draws correctly), can only be employed with a bright light.

With the full opening, the lens is focussed on the centre of the picture (with the Steinheil lens), or half way between centre and margin (with the Doublet lens); after this has been done the stops are inserted. For line drawings, a stop should be used so small that the picture is sharp to the edge. For oil paintings, larger stops should be used, to gain light.

5. PROTECTION OF THE OBJECTIVE AGAINST FOREIGN LIGHT.

This protection is absolutely necessary for drawings, where it is the object to obtain clear lines. A black box, and a piece of pasteboard in which a hole has been cut, just large enough to show the drawing, but excluding everything else, is placed in front of the lens. A wide tube placed over the objective, in which another tube moves, like a

telescope, is also of advantage. Landscape lenses do not require this protection as much as portrait lenses.

The whole field of view of the lens should not be used, as this would expose one to a considerable loss of light towards the margins.

6. TIME OF EXPOSURE.

The correct time of exposure is not so easily determined in *reproductions.* We must distinguish between black line drawings without half tones, copperplate prints, and pictures with half tone. When the former are exposed too short a time, the picture develops slowly and looks pale; all the lines are transparent, and it requires long intensifying, and the film is apt to become brittle and to split. When the exposure is too long, the black lines will finally exert some action, and will appear, after development, *weak* and *foggy;* they will print *gray* instead of black. Generally speaking, in line drawings, over-exposure is worse than under-exposure; just the reverse from landscape or portraits.

Drawings with *half tones* require longer exposure than line drawings, in order to get details in the shadows. Drawings with *half tones* and *lines* give the greatest difficulty. When we expose for *half tones,* we get partially veiled lines; when we expose a shorter time, the lines will be black, but the half tones will be hard, and the shadows will be wanting in detail. Of the two evils, we should choose the least. Draughtsmen, who work for photographers, should accustom themselves to drawing with deep black lines on white paper. Gray lines give the most trouble; for instance, the glossy lead-pencil line. Copperplate prints also cause some difficulty; generally they are only medium black, and we often get copies which are blacker or weaker than the original.

To copy oil paintings correctly was formerly considered an impossibility. The colors, of course, cause much difficulty; a sun of chrome yellow will appear as a black spot, an ultramarine blue sky will appear white, not to speak of other colors. The most obstinate color is brown, and brown photographs are only with great difficulty reproduced. Fortunately the reflected light from the colored surface acts a little, but generally speaking a longer exposure will be necessary with oil paintings than any other pictures when we wish to get detail in the shadows and in the inactive working colors. Every picture should be examined most carefully after development. When the details in the shadows are insufficient, the time of exposure should be increased; sometimes this does not insure success with such colors

as umber and dark green. Under these circumstances nothing remains but to replace the missing tones by negative retouch. Clouds and sky have often to be strengthened by negative retouch, as they will be visible in the negative, but do not offer sufficient contrast. In regard to the technicalities of negative retouch, I would refer to the chapters on that subject in the splendid work of Mr. Ayres, entitled "How to Paint Photographs."

7. METHODS OF OPERATION—FORMULÆ.

The different operations should be carried on with the formulæ given above. For half tone pictures and oil paintings, I use a strong developer; for line pictures, I take a feeble developer.

For long exposures particularly, precautionary measures are necessary. The repelling action of the collodion film is very apt to produce marbled stains. Collodions from which the bath runs off in greasy lines are not suitable for long exposure. On the other hand there are "moss stains" caused by particles of dirt from the plate-holder which become imbedded in the film, and finally drying spots, by actual drying of the silver solution on the plate, in which case the iodide of silver is dissolved by the concentrated bath.

To prepare wet plates for long exposure, M. Carey Lea recommends, in the "Philadelphia Photographer," the following:

1. Marbled stains, which show themselves particularly in the centre of the plate, are best avoided by dipping the plate into the silver bath immediately after collodionizing.

2. Spots, which in spite of these precautions will appear, and particularly at the lower corners, are best avoided,—

a. By the use of two baths,—an old one for sensitizing, and a new one for dipping the sensitized plate after it has been taken from the first bath. Take the second bath only 5 per cent. strong.

b. By placing a thick strip of blotting-paper, which is bent over lengthways in such a manner that one part is about one-eighth of an inch wide, and the other one inch wide; the part which is one-eighth of an inch wide is placed under the plate, when it is placed in the plate-holder, in such a manner that the plate rests on the thick and narrow layer of paper. The wider part is then placed on the back.

c. By placing in front of the sensitized plate a piece of plate-glass in the holder.

d. By placing damp cloths in the camera.

To keep the plate-holder clean is a matter of course. By following these directions an exposure of half an hour or more is possible.

Covering the back of the plate with wet blotting-paper, and employing a spongy collodion, *rich in bromine,* is also a remedy which is to be recommended.

Jabez Hughes recommends, besides *the above-named remedies,* the employment of *washed wet plates.* The plates, after they have been sensitized, are placed in a large dish with *very pure distilled* water; they are moved for about three minutes, the superfluous water is allowed to drip off, and then they are used. Before development they are returned to the silver bath, and moved in it for at least one minute.

In the development, the rapid or slow appearance of the picture is a criterion whether the picture has been over or under-exposed. Intensification is, particularly with line drawings, a point of *great importance.* The plate must be intense enough to offer a considerable obstruction to the passage of light, otherwise we will get a reproduction in which the ground is gray instead of white.

Photolithographers and photogeographers require very thick and opaque prints. For this purpose Osborne uses the following method of intensifying. After the iron solution is fully washed off, the plate is immersed in a solution of 5 parts of iodine, and 10 parts of iodide of potassium, in 100 parts of water, and remains in it until it becomes yellow. The plate is then thoroughly washed, and a weakened solution of sulphuret of ammonium is poured over it, which changes the color to a reddish-brown tinged with black. After the plate is well washed and dried, it is varnished in the usual manner.

Mr. M. Carey Lea recommends the following:

Cold saturated solution of bichromate of potash, .	3 fluid drachms.
Hydrochloric acid, ...	1 drachm.
Water, ...	6 ounces.

This solution is poured upon the plate after it has been intensified with pyrogallic acid. The color of the film changes rapidly into a splendid lemon-yellow, and the lines seem to become a little clearer. When the solution has been removed by washing, a solution of sulphate of ammonia is employed, and this changes the color into a deep chocolate-brown.

The only point which requires particular attention is the washing of the plate after each operation, for when this has been neglected the lines will run together, be covered with precipitates, and the negative will be spoiled.

8. THE PRINTING.

Perfect negatives will print easy, and do not require any artificial

help. The printing is carried a little into excess, that the high-lights may show a little color. In toning, the high-lights will become white. Negatives in which some parts are too thin, others too thick, have to be copied with a mask. The thin parts are copied first; when ready they are covered with suitably cut pieces of pasteboard, and the dense parts are printed until they reach the necessary amount of color. The tone of the picture should be kept very black by employing an alkaline or chloride of lime bath. See remarks thereon.

9. CRITICISM OF THE RESULT.

To judge of the result, the severe and critical comparison between the copy and the original is not very difficult with drawings and prints, as both are monochromatic. It becomes more so with oil paintings. With these the effect of color has to be reproduced by the mere graduation of tone between light and dark. We have to observe at the start that in photography the cold colors (blue) are reproduced too light, while the warm colors (yellow and red) are rendered too dark. This contrast has to be equalized if the picture is to be true. We have, so to say, to analyze the colored original. We have to ignore the color, and have to observe what should be light, half shadow, and dark; what should be prominent and what not.

When, in a photograph, the proper gradation between light and shade is wanting, the figures will not separate; the picture, in short, lacks character, and is worthless.

Whoever wishes to photograph works of art correctly must be an artist himself, or else submit to the superior judgment of an artist.

There are hundreds of reproductions of oil paintings in the market which show light where the original is dark, and *vice versa;* or where the several figures which in the original are properly separated by contrast of color, appear in the copy as an undefined mass; or large surfaces show nothing but shadow where the original is full of delicate detail. All these several points have to be observed, and only by exercising a sound criticism can a satisfactory result be secured. Oil paintings, which have become dark by age, and in which the eye does not recognize any details, of course cause more difficulty than new ones.

Reproductive photography is a branch which stands on the border between the purely mechanical and artistical activity of the photographer. So far as it is based on artistic principles, it belongs to the chapter on Photographic Æsthetics; practical considerations induced me, however, to treat of it in the purely technical part of my book.

SECTION II.

THE "LICHTPAUS" PROCESS.

By "Lichtpausen" is understood the direct printing of a sketch by the aid of light, without application of the negative process. This is one of the simplest photographic processes in existence, because it only requires the operation of the positive process (see above), to which it has some similarity. One thing is dispensed with, namely, toning, which is of little consequence, it being immaterial whether the technical drawing has a brown tone or not. This process has the one advantage above the negative process: it can furnish prints in original size to dimensions, which, in the negative process, cannot very easily be obtained. The process, since the sensitized paper can be bought already prepared at the dealers,* is so simple that persons not acquainted with photography can practice it with the greatest ease. This accounts for its universal application in large machine shops, bureaus of architecture, etc., etc. In this process, both negative and positive are made, but both on paper *without* development. The negative is formed by exposing the sensitized paper under a drawing or sketch; the black lines keeping off the light will be produced white, and the whites of the original black. It is best to use plain paper; albumen paper is apt to curl or roll, and break. The sketch to be printed must shine through, and have some vigor in its lines. It is, however, totally superfluous to make the sketch transparent with paraffin or varnish; under certain circumstances possibly it might be spoiled. Sketches will print without this, of course a little slower the thicker they are. Even originals on copperplate printing paper can be printed; of course, the paper must not be too yellow. Colored sketches will print as good as those not colored, except aniline blue. The more opaque the lines of the original are, the more brilliant will be the print. It is to be recommended to sketchers to add vermilion or Vandyke brown to their india-ink in sketching, to make them chemically more opaque. Conditions to attain a sharp print are that the original drawing and the paper should be in close contact. To effect this, they are pressed together in the printing-frame as usual, the sketch laid in the frame, picture-side up, the sensitive paper on top. If the wrong side of the sketch is laid up, they are separated the thickness of the paper, and it will be impossible to obtain a sharp

* It is manufactured by Herr Talbot, No. 11 Karl Street, Berlin.

print, unless the paper which holds the sketch is very thin. In regard to contact a good pressure is important. Talbot has introduced sheep-wool bolsters, which are better than the paper pads, which are easily rumpled and then press unevenly. Several thicknesses of cloth can be used. The pressing pads are placed on the paper, the frame closed, and inspected from the front or glass side; if any folds or pleats have formed at all (best done in a light falling sideways), they are removed by pieces of cardboard placed back of the paper. Drawings the size of 45 centimetres are easily pressed flat in this manner; larger ones are more troublesome. To keep these flat, it is best to stretch them on the plate in the printing-frame. Wet the back of the sketch with a sponge, and paste it on the glass. In drying it will be perfectly flat, and print very well. The sketch can afterwards be removed by moistening with hot water. Care must be taken that the original is fully dry before laying on the sensitive paper, as the silver is apt to adhere to the paper and make spots. Spots of this kind can be removed with chloride of mercury; it is better, however, to avoid them. In regard to the printing, it is the same as printing from a negative. The prints must be examined occasionally, to watch the progress of the process, and printed deeper than the picture is intended, as it will come up lighter in the fixing bath. It is better to print too dark than too light, as the dark ones can be bleached, too light ones cannot be cured. Prints on Talbot's paper can be kept for weeks, without fixing, in the dark. The toning is dispensed with. In behalf of fixing, the prints are washed once in water. Asphalted wooden dishes, as furnished by Talbot, will answer, and must be kept perfectly clean. Care must be taken to have clean fingers, and avoid hypo stains. The prints are saturated, and left to soak in water about three minutes; afterwards dip in the fixing bath.

Hypo, ...	1 pound.
Water, ...	5 pounds.
Ammonia, ...	¼ pound.

The latter neutralizes any acid often contained in the paper. Papers which are dipped in without washing, will fade from the influence of the acid. The first wash-water is saved, and the silver contained precipitated with table-salt (see above). By taking large sheets out of the water, care is necessary to avoid tearing. In immersing in the fixing solution the prints change from a violet to a brown color. The second print is placed into the fixing solution when the change in the first has completely taken place. Remaining in the fixing solution ten minutes, they are placed in a dish of clean water for three

minutes, and from this into another one. This is repeated eight times. Small prints are hung up with clothes-pins to dry; large ones are dried on blotting-paper. The washing of the latter is best accomplished in one dish, which has an opening in the bottom, with a gum hose attached. Let the water off with it, and change eight times. In washing and fixing the prints, the tilting to and fro of the dish must not be neglected, so as to further the flowing of the solution. If the solution do not moisten and penetrate the prints thoroughly, ordinary fixing and washing are impossible. Insufficient washing turns the prints yellow. To ascertain if they are sufficiently washed, apply the iodine test. Too dark prints are bleached by placing them in a solution of 1 part of cyanide of potassium to 500 parts of water, and tilting the dish to and fro diligently. The bleaching occurs from the silver dissolving, the outlines consisting of brown metallic silver. With the negative so produced, the position of which is reversed to the original, a positive can be produced in the manner described, which fully resembles the original. Very large drawings are copied in pieces or parts, by folding them so that one part covers the back of the paper. With small pieces of paper, large drawings can also be printed by placing them so that the edges overlap each other. Any part of the drawing not desired can be touched out with india-ink. White spots in the negative are touched out in the same manner.

SECTION III.

PHOTOGRAPHING OF MODELS, ORNAMENTS, STATUES, WORKS OF ART, MACHINERY, ETC.

1. PREPARATION OF THE OBJECT, AND ARRANGEMENT.

It is difficult to find general rules for the parti-colored medley of objects which have been arranged in this section, as these have to be modified by every especial case, and I will only try to develop those principles which one dare not neglect in taking the picture of such objects as are named above.

The rules which are laid down for reproductions also hold good here. Everything which does not belong to the object proper should be removed, and no pains should be spared to make the object as elegant as possible before proceeding to the taking of the picture.

The objects which come under this head are either easily removed (can be transported to the atelier) or not. The latter have to be taken at the spot where they are located, with all the accidental sur-

roundings—landscape background, spectators, etc.; sometimes with an unsuitable or even impossible illumination, in dark cellars, etc.

Objects which can be brought to the atelier are best placed in front of a monotonous or plain background. According to the nature of the object different shades are necessary. As a general rule, we may state *that the object must contrast with the background.* They must not be equally light or dark. It will be observed that the background becomes darker by moving it away from the object. This enables us to make a completely black background on the picture with a screen which naturally is only gray. A background which is too dark can be lighted up by a suitable illumination. As a basis we should select a dark table or a support of a sombre color. *All other things should be removed.* A vertical position is almost a matter of course. The selection of the position of the camera is of much importance. The camera has to be placed at the spot where an expert, but not a photographer, would place himself to get a full view of the whole object. The direction in which the camera is placed should correspond with the direction of the eye of such an observer. It is therefore necessary that the photographer should perfectly know his subject if he wants to select the proper standpoint. Of what use is the most brilliant picture of a piece of machinery when the main things are hidden by secondary matters. Sometimes this may depend on a single wheel or a single screw. It is the same with objects of art. The photographer has to study his subject, exactly as the actor has to study the character which he is to represent.

Whoever wishes to take pictures of plastic figures must understand the plastic art; he must be possessed of artistic judgment, or he will commit gross errors.

The same holds good for technical objects, as stores, machinery, tools, and reliefs. Any one, not being an expert in these matters, should at least consult some one who understands it thoroughly. In taking works of the plastic art, he should consult the sculptor; in taking technical objects, he should consult a mechanic, who will point out to him which parts are essential and which are not. The engraver has to do the same when he desires to make an engraving of an intricate piece of machinery.

The advantages of photographic pictures of technical objects have often been estimated as being of very little value. The reason is that the pictures were made by photographers who did not understand their subject. Not photography but its disciples are to be blamed. My space does not permit me to give detailed instructions to every one who wishes to photograph statues, or machinery, or architectural

objects. Fortunately our literature is not deficient in such works, and it is the duty of every one to instruct himself in these matters.* The cultivation of these specialties is the reason why we have nowadays portrait photographers, landscape photographers, and architectural and technical photographers. The practical manipulations are nearly always the same; but the particular success in any one of these branches is based on particular knowledge of the subject-matter. It is not unusual to find that a skilful portrait photographer will make a poor hand at landscape photography, and a good worker at reproductions will fail completely in portraiture.

When the proper side from which the picture should be taken has been found, the distance is the next important subject. When the camera has been placed too near, perspective exaggerations are apt to take place; even with the best of lenses the nearer parts appear too large. When the camera is removed too far, the relief is apt to seem too flat. The photographer will be very apt to make the *former* mistake from *want of distance*, and (when working in a contracted space) he often has no other choice. Vertical position of the camera is generally necessary, particularly when taking technical objects (models, etc.). Under certain circumstances, however, an inclined position of the camera has to be selected. Take, for instance, a statue on a high pedestal, which we are accustomed to see from below, and which has been constructed by the artist with reference to this position. It would be absolutely faulty if we would copy such a statue in the atelier on a level with the camera. On the contrary, it should be placed high, and the apparatus should point upwards; by doing so we will only conform to the natural conditions for which the statue has been constructed. We know works of art, as, for instance, the George's Head, by Kiss, which, when seen from a level, look indifferent, and only make a startling impression when viewed from below.

We often sin against these principles. Portrait photographers, who are accustomed to incline their cameras on the sitter, too frequently apply this position for all other objects. I would here call the attention of the photographer to what will be said in the article on PERSPECTIVE.

2. ILLUMINATION AND EXPOSURE.

The selection of the proper illumination is as important as the selection of the proper standpoint. Artistic objects require analogous considerations to portraits (see Æsthetics); technical objects must appear

* We would recommend Lübke's History of Architecture, also Lübke's History of Plastics.

distinct in all particulars; dark shadows, which are apt to obliterate some details completely, should be avoided. The light of a high atelier, which pours in uniformly, is preferable. Objects which have to be taken in a given locality can of course not be brought into a suitable illumination. We have to wait for the suitable moment, and very often we have to assist with mirrors, magnesium light, or other artificial means.

By the aid of a mirror sunlight is thrown on the object (it is best to follow the direction of the camera); and by slightly moving the mirror the light is passed to and fro over the whole object. Objects which are much hidden can often only be reached by two mirrors, and the light proceeding from the first has to be caught by a second one, and is from it reflected on the object. Of course, with such a process, much light is lost. The time of exposure, for such an illumination, in July, with a Steinheil lens, and third largest stop, is with a single mirror, about six minutes; with two mirrors, from nine to twelve minutes; the object being dark.

The following principles of illumination and perspective refer to all objects. The specially noted lifeless models are very different in their character; sometimes purely artistic, as plaster models, marble figures, etc.; sometimes purely technical, as models of machinery; sometimes of a dark color (cast iron); sometimes white (plaster of Paris).

How extremely different the treatment of such bodies must be is self-evident. A white figure requires a dark background, a dark one (bronze or iron) requires a light one; the former a short exposure, the latter a long one. Remember, too, that high-lights often make their appearance on metallic objects, and require to be modified by suitable illumination, or by dusting the respective parts with gray chalk. Still more annoying are colors; very often we have to distinguish between red cast (copper) and bronze; both act photographically alike. We must resort to negative retouch for separating parts which should be kept apart, but which will run together on account of color.

For taking buildings in the open air, a light falling from the front at an angle of 45° is the most advantageous. The exposure should be continued until all the details in the shadows appear.

3. LENSES.

In the selection of lenses *freedom from distortion* should be looked for. For objects that give out very little light, portrait lenses should be used; where correctness of drawing is the main object (machinery), *doublets* or *aplanatic lenses* are the best; with a large angle and short distance, the *pantoscope* is preferable. I repeat, that acquaintance

with the object is necessary for the proper selection of the lens. The same refers to stops.

It is advantageous to place over a piece of machinery white graduated marks lengthways, perpendicular, and horizontal; they should be included in the photograph, as with a knowledge of the perspective the dimensions can be reduced from them.

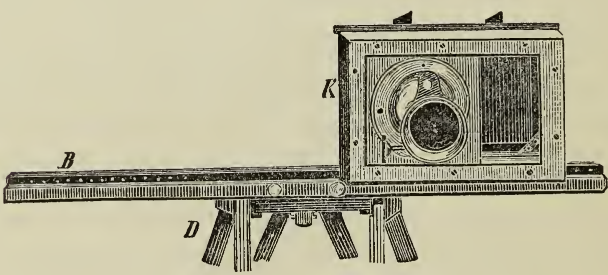
The negative and positive processes are practiced according to the rules given in previous chapters. A strong developer, however, should be used.

SECTION IV.

STEREOSCOPIC PICTURES.

For taking stereoscopic pictures, it is necessary to have two views of the same subject, one a little from the right, and the other a little from the left side. These pictures (see Part I) can be made, first, in a very simple manner, with an ordinary camera set on a stand, with a wide board. The board *B* (Fig. 78) is perpendicular to the line of communication of the viewer with the object. Take either a camera with a movable holder, in which two pictures are made one after the other, or one with a movable object-lens and internal divisions (*K*, Fig. 78). Such a camera is first placed on the right side of

FIG. 78.



the board towards the groove. The right-hand picture is taken on the left side of the plate, looking at it from the rear. Next the camera is placed on the other side from *B*, and we take the left side of the object on the right side of the plate. That the camera retains exactly the same distance from the object is very necessary, and the board should be placed very firm. The binding-screw, *K*, of the camera passes through holes bored in the board, or runs in a groove, in order that the position of the camera may be fixed at any time.

The length of the board for distances of about twenty-five feet is

about a foot. With nearer objects it is less. With great distances we take four to five feet and even more. When too much length has been given to the board for near objects, they will appear unnaturally solid, while the reverse produces pictures that are flat.

This method will not do for moving or living objects, as these are apt to change their position, and the second picture, even if it should be sharp, would not be in its proper place, and would appear distorted in the stereoscope.

Even in landscape photography this method has great drawbacks, as the illumination will sometimes change between the taking of the first and second picture.

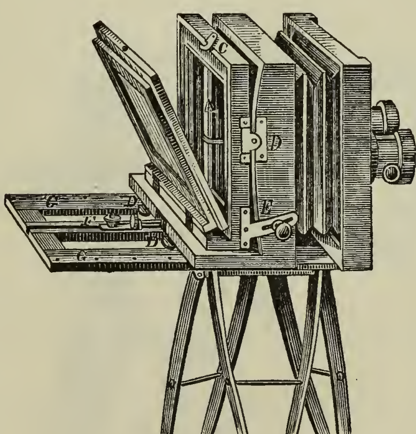
The second method is with a camera with two tubes. With it both pictures are taken at the same time. A change in position or illumination has no influence here, as both pictures are taken simultaneously; but as the tubes cannot be very far removed from one another the right and left view differ very little, and the distances do not appear very solid.

In Germany we use the German and English boxes for this work.

A very practical camera for stereoscopic work is the one called the "Philadelphia Box," made by the American Optical Company, New York, and one of which was presented me by the Scovill Manufacturing Company.

It consists of a rigid front part (Fig. 79), and the back part, *D*, which moves back and forth on the platform. It also has fronts for the tubes. The focussing is done by moving the back part over the brass guides, *G G*, and securing the *exact* focus by using the focussing screw, *F*. The opening and shutting of the tubes is done with a cloth, the common method, I find, in America. Some of the foreign boxes have an instantaneous front, which moves around an axis, and which can be rapidly raised and depressed by turning a knob. The exposure can, of course, be lengthened at pleasure. The whole arrangement fits only loosely on the objective,

Fig. 79.



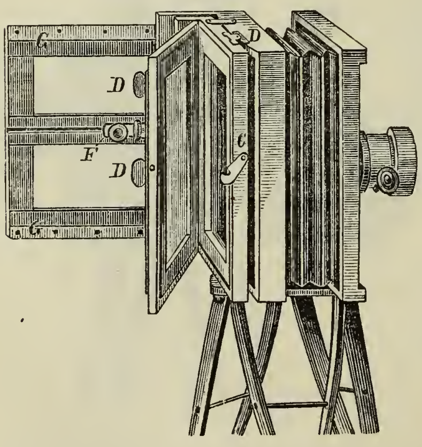
and is easily removed. The front board with the stereoscopic lenses it also easily detached and replaced by another board carrying a single lens. This same arrangement may be applied to the American boxes when necessary.

The inside of the camera is divided by a movable piece or diaphragm *A* (Fig. 79), which moves in a groove, and which doubles on itself in shortening the camera, and lengthens when the camera is pulled out, so as always to completely divide the camera into two parts.

Fig. 79 represents the box as it is used for ordinary stereoscopic work. The platform is hinged so that it may fold up compactly; the bellows is rubber; the swing-back, which is indispensable for landscape work, is attached; the front raises and lowers, and the holder is made to fit on pins, which is far preferable to a holder which slides. The ground-glass is hinged fast. Fig. 80 represents the box turned over on its side, for the purpose of making an upright single view with one tube, as recommended by Wilson. The partition or diaphragm *A* (Fig. 79) is removed, so the plate is not obstructed or divided. *C* is a clasp which holds the holder in place when the exposure is being made, and at *E* is a clasp and screw, which keep the holder at a proper swing or angle when it is necessary to use the swing-back. *G G* are the metal guides; *D D* screws which bind the platform to the box when in use; *F* the focussing screw.

The plate-holders have corners of solid glass on which the sensitive plate rests. Drawings of them will be found on another page.

Fig. 80.



The lenses which may be used with this camera have an opening of $1\frac{1}{4}$ and $1\frac{1}{2}$ inches, and from $3\frac{1}{2}$ to 6 inches length of focus (calculated from the back lens). They should be provided with stops; the sizes so arranged that with each one twice as long a time of exposure is required as with the next larger one. But stops are only necessary for very near objects. Long distances we can work with the full opening.

The above-described screen for taking instantaneous pictures offers

some difficulties. Great care has to be observed that in moving it neither the tubes nor the camera are shaken. The taking of instantaneous pictures requires steadiness and skill.

Lately another instantaneous shutter has been invented, which is warmly recommended by Remelé.* It consists of a wooden box which is placed over the tubes. In the box is a curtain which, by being pulled over the tubes, shuts out the light. This can be done rapidly or slowly, as circumstances may require. This arrangement admits also of giving different lengths of exposure to different parts of the same picture; for instance, the sky and distant parts of the landscape may receive a very short exposure, and the foreground considerably more without interrupting the pulling of the curtain-string a moment. With many landscapes, for the longer exposure of the foreground, and the shorter time given to the sky, it is of great importance, particularly with distant views. With a lid the illumination would have to be an average one, or the middle parts of the picture would be correctly timed, while the background and sky would be completely over-exposed, and the foreground, which generally shows some foliage, would be wanting in detail. By giving a short exposure to the sky the most beautiful cloud effects can be obtained. The pictures which are made with the above curtain arrangement show a beautiful harmony, and many faults in the illumination which we see on other pictures are entirely avoided.

Rouch has constructed a screen for instantaneous pictures which has two shutters instead of one, as in the other arrangement. These shutters turn around a small axis, which is provided with teeth which connect them with a swivel on the centre of the box at each side. It is evident that when the upper shutter is turned with the knob the lower shutter will have to turn also, and that both must move in the same direction. When the arrangement is closed by the upper shutter then both shutters will stand vertical above their axis; when the knob is turned backwards the lower shutter will be depressed, and the tubes will be opened, but will be closed again immediately when the upper shutter places itself in front of them.

The movements of the apparatus are simpler than those of the Dallmeyer instantaneous shutter, but it requires skill and steadiness to operate them.

Braun, in Dornach, manages the opening and shutting of the tubes in a peculiar manner. He closes both tubes with a black cloth which

* Remelé's Handbook of Landscape Photography.

he holds flat in the hand; he removes it rapidly, and replaces it as rapidly again. This movement, however, requires much practice.

For portraiture the lenses should be $2\frac{1}{2}$ inches distant (the distance of the eyes). For landscapes a greater distance is desirable. English mechanics have *placed the tubes on boards which can be moved in a horizontal direction, which admit of their being placed a little closer together or a little further apart.* Of course the shutter arrangement is not always applicable to this arrangement.

All kinds of lenses are used for taking stereoscopic pictures:

1. Portrait lenses, where a quick-working lens is desired (for moving objects, portraits, instantaneous views, etc.).

2. Doublets, aplanatic lenses, correct wide-angled lenses, where correct drawing and a large field of view is desired. Vertical position of the camera is necessary. The tube must have an arrangement by which it can be raised and lowered, in order that the picture on the ground-glass may be centred. By raising the tubes the sky will become larger, by lowering them the foreground will increase in size.

3. Landscape lenses, where a little distortion does not amount to much.

The methods of operation are in no way different from the ordinary methods. Plates should be selected which are a little larger than the picture is to be. In this way spots at the corners are easier avoided. It should also be observed that plates taken in the double camera show, when seen from the glass side in an upright position, the right side to the left, and the left side to the right. They must, therefore, be cut apart, and their positions reversed.

When this is done at once with the plates it will afterwards no longer be necessary to do it with the prints. When, however, the pictures are farther apart than $2\frac{1}{2}$ inches, which is the ordinary stereoscopic distance, it is better to print them together, and to reverse them when ready for mounting.

The difference in the amount of light in two different lenses is often a great drawback, as they will yield pictures of different intensities, and one is compelled in such cases to stop the one lens until it corresponds in intensity with the other.

It happens more frequently that the thin end (the end first poured upon) of the stereo plate, is not as sensitive as the thick end (running-off end). Through this the pictures are constantly uneven. This can only be avoided, in coating plates, by pouring on a goodly quantity of collodion, letting it flow backward over the plate before leaving it run off the plate. For the above reasons, plates larger than the picture should be used.

INSTANTANEOUS PICTURES.

There was a time when instantaneous pictures were the theme of every-day conversation, and when they gave rise to the most wonderful illusions. The representative Faucher made, in the Prussian Chamber of Deputies on July 1, 1869, the following remarks:

"We have now instantaneous pictures. By this process portraits can be stolen, and perhaps the most extraordinary precautionary measures will be necessary to guard against such a theft; perhaps it will finally be necessary to wear a mask."

These rumors probably owed their origin to the splendid stereos of Braun and Ferrier with walking figures, carriages in motion, horses, etc. The public as well as photographers considered it possible to produce instantaneous pictures in the atelier. Even photographers advertised themselves in the papers as "instantaneous photographers," and very often we heard in those days the exclamation, "Yes, if I had his collodion," as if everything depended on the collodion.

I have mentioned in another place that the production of instantaneous pictures is only possible under certain favorable conditions: (1) a good collodion; (2) bright light; (3) a lens that gives a great deal of light; (4) a new and pure silver bath; (5) a strong developer.

But even to this day we hear of instantaneous portraits. "There must be something in it," say a great many; and here we must refer to an episode in the Berlin Photographic Society, when Mr. Ahrens put the question, "What is a photographic moment?" The answer was, "Three seconds."

Of course, instantaneous pictures have been taken in much shorter time than this, but what are they like?

In a good portrait we want modulation. This can only be obtained by a skilful direction of the light, which must not pour in from all sides, but must be excluded here and there.

But this diminishes the quantity of light, and does not suffice for condition No. 2.

On the other hand, clearness in the shadows is demanded; this can only be obtained by long exposure.

Hence, the real instantaneous pictures, taking, for instance, a space of time not more than one-tenth of a second, are reduced to landscapes with their accessories in clear, sunny weather. And for this purpose we recommend—

1. Collodion made by any reputable party, or, when the photographer wishes to prepare it himself, make it according to formula given.*

* When the following conditions are observed, a less sensitive collodion will suffice.

2. Apparatus—a double objective of short focus giving much light, with an instantaneous shutter.

3. Bath, 1 : 10, freshly made of crystallized silver and one-quarter per cent. of the salt of iodide of potassium.

4. Developer after Remelé: viz., 5 iron, $1\frac{1}{2}$ glacial acetic acid, 100 water (alcohol is not always necessary). Some "instantaneous collodions" of commerce are apt to work foggy with this developer. In that case more acid should be added.

5. Intensifying and fixing as usual. The same conditions apply to taking portraits with a short exposure in the atelier.

To any one who wishes to make instantaneous pictures, I would recommend to place himself in such a position that the majority of the movable objects approach or move away from the apparatus. In this case the change of position is apparently the smallest; in taking a view of a street we should look into the street lengthways, and marching soldiers we should take in the direction of the march.

TENT WORK AND PHOTOGRAPHIC EXCURSIONS.

In the previously described operations, the existence of a laboratory in which the plates are prepared and developed has been considered as a matter of course. But there are plenty of cases where such a laboratory does not exist, and where pictures have to be taken at a distance from the atelier of the photographer. A dark-room has to be prepared before the photographer can commence to work. In case of necessity any inclosed space that can be made light-tight, can be used as a dark-room. Braun, in Dornach, does not hesitate to use cellars, stables, outhouses, etc., as dark-rooms, but it always depends on how far we can work here without being molested by dust or stench. As such a space cannot always be improvised, the travelling photographer will do well to carry his own dark-room along. For such a portable room nothing is better than a tent, which, above everything else, must be light-tight, solid, easily put up, and sufficiently comfortable.

The number of dark-tents constructed is legion. It cannot be said which is the best, as it depends very much on the personal wishes of the operator, one preferring this to the other construction. The dark-tent should have a table-surface of three or four times the length and breadth of the plate to be prepared therein, easily and rapidly set up, and not to be too heavy. The sides of the tent are therefore best made of black double English satinet. For light, a window is made of yellow Parisian oiled silk, four thicknesses. The tent represented in

the annexed figure, which the author saw at Kilburn's, in Littleton, and which proved itself very serviceable on his tour to the mountains of Thuringia, consists of a folding wooden frame with a plate *B* (Fig. 81), which serves as a work-table, and an open top-piece, *A*, which is covered with black cloth. The table and top-piece are connected by the hinged folding-pieces, *m m*. When the hooks, *h*, *h*, which fit into the eyes, *KK*, are unfastened, the supports, *m m*, fold like a pocket-knife, and the frame lies perfectly flat. Inside of this wooden frame the four-cornered tent-cloth is fastened. It is nailed to the top-piece, *A*, and the table, *B*. At *H*, Fig. 81, is the window of oiled silk; at *V*, Fig. 82, is the front curtain through which the operator has to creep and seat himself on the camp-stool, *S*. At *q*, Fig. 82, is an opening for ventilation; at *x*, Fig. 81, is a large opening in the table, which is lined with caoutchouc cloth, and forms a kind of a dish; it serves to receive the developing solution as it flows off the plate. Through a hole in the centre the waste solution is discharged, and india-rubber hose is not absolutely necessary. At the top towards the left hand is placed a hook to hang an india-rubber water-bag holding five litres; a gum hose is stuck in, leaving one end hang down, forming a siphon. It is closed by means of a small squeezing cock. The tent is placed on four legs, *b*, *b*, *b*, *b*, Fig. 82. These are either screwed on, or they are fixed with hinges, and fold under the table; binding screws, *S*, *S*, serve to fasten the legs in position when the tent is erected. When we desire to fold the tent, the curtain, *V*, is first pushed inward, the camp-stool is placed inside (also the feet, if these should be arranged for unscrewing); the hooks, *h*, *h*, *h*, *h*, are next undone, and the top-piece, *A*, is lowered. The

FIG. 81.

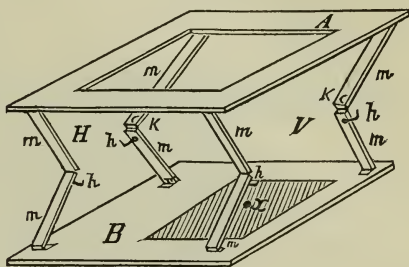
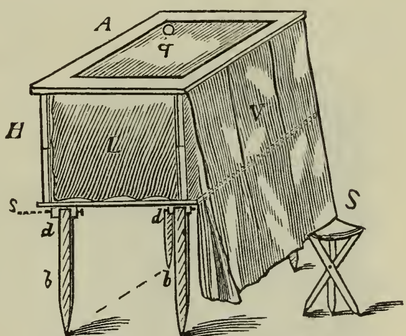
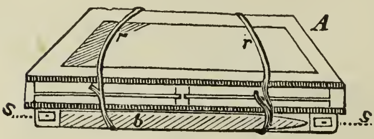


FIG. 82.



tent-cloth has ample room between the supports, *m, m, m, m*, and is protected by them; the feet are folded, and the whole is strapped together by the straps, *r, r*, Fig. 83. The straps serve also to carry the tent, and it may be carried on the back like a knapsack; size of plate 30 x 20 inches, weight eighteen pounds, time necessary to erect it seventy-five seconds.

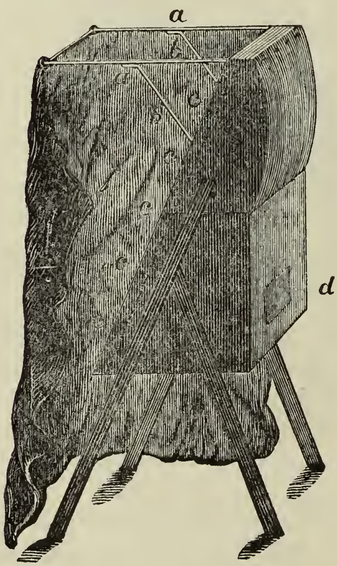
Fig. 83.



The tent is placed in a shady place, protected from the wind. In very warm countries sprinkling the tent-cloth and the bag containing the silver bath with water is an excellent way of keeping both cool.

A similar tent, and one which is very solid, is described by Ph. Remelé in his excellent "Handbook of Landscape Photography." The tent is the invention of L. Herzog, in Bremen. The most essential part of the whole tent is the box necessary for the transport of apparatus and chemicals. The box is opened and four strong wooden legs are attached; on the top a folding iron rod, *a*, is pushed into the corresponding holes and fastened by the rods, *b, b;* over the rods a tent-cloth is thrown, and with hooks it is fastened to the eyes, *c, c, c,* above, below, and on both sides. The tent-cloth should be double at the sides, that it may be hooked in the interior of the box in a similar manner. At the lower extremity the tent-cloth has an opening; the operator creeps into it and ties it light-tight around his waist. At *b* there is a door in the box, which can be opened and shut, and here a window of oiled silk is fixed in.

Fig. 84.

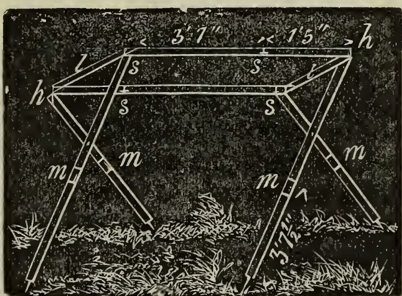


The best material for a tent is the so-called india-rubber cloth; the hooks are fastened to it with gum bands. Overhead a yellow window of oiled silk is placed. This tent is remarkably solid, offers much space for working, and has, finally, the advantage that one can work in it without wasting a drop of silver or any other solution on the floor.

Braun, in Dornach, uses for the preparation of large plates a tent, consisting of a folding-frame, *m m*, with a dark cloth thrown over (see Figs. 85 and 86).

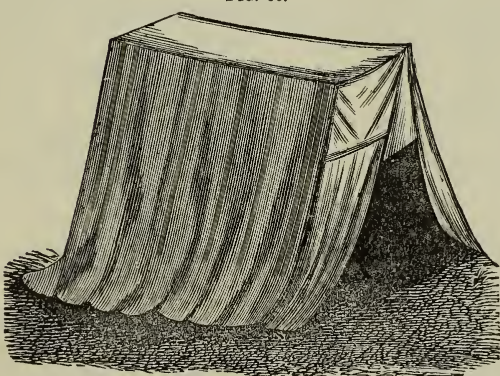
For excursions all the other objects necessary for operating have to be taken along. I carry a basket with a lid, which is divided in

FIG. 85.



squares; in such a basket all the requisites are easily packed, and the bottles are much less exposed to breakage, owing to the elasticity of the basket, than they would be in a wooden box. Four-cornered

FIG. 86.



bottles are preferable to round ones. The packing of the bottles requires the stuffing in between of some soft material; the best for this purpose is rags or paper. (Tow or hay will make too much dust.)

I also, for transporting, make use of a box with a lid, having several four-cornered partitions lined with felt, in which all bottles can be easily packed; four-edged bottles are preferred for this purpose.

The box contains on one side a compartment with one dozen plates 7 x 9, and of all the chemicals used as much as is necessary to prepare them. The weight of the box is moderate ; it will answer fully for a day's excursion. Its contents are easily replenished, with a stock of chemicals left at the hotel while travelling. The quantity of chemicals depends on the size and number of plates.

In Dr. Vogel's Pocket Reference Book, the quantity of chemicals necessary for plates of 1 square foot is given. Per square foot (equals $\frac{1}{10}$th square metre, size of plate), 25 cubic centimetres of albumen solution is necessary (see Albumenizing). Silver bath according to the size of the bath-holder (see Bath-holder and dishes). Collodion 16 grammes, developer 300 cubic centimetres, intensifier 48 cubic centimetres, fixing (cyanide) 100 to 150 cubic centimetres. Water to wash before fixing, 2 litres; water to wash after fixing, 8 litres; varnish $7\frac{1}{2}$ cubic centimetres. If in want of water, the fixing, washing, and varnishing are done at home.

The following articles are necessary for a photographic excursion:

(*a.*) *For short excursions.*

1. Tent.
2. Camera box.
3. Tripod for same.
4. Connecting screw for 2 and 3.
5. Plate-holder, with frames.
6. Tubes, with camera box fronts.
7. Focussing glass.
8. Plate box.
9. Cleaned plates.
10. Duster.
11. Dipper.
12. Two focussing cloths.
13. Water-can and rinsing-water.
14. Bath or dish.
15. Alcohol lamp.
16. Photogenic lamp.
17. Negative bath.
18. Collodion.
19. Developer.
20. Silver for intensifying.
21. Alcoholic pyrogallic solution.
22. Distilled water.
23. Cyanide of potassium.
24. Some empty bottles and corks.
25. Varnish for negatives.
26. Graduate.
27. Two funnels.
28. Alcohol.
29. Filtering paper.
30. Writing paper for scumming the bath.
31. Matches.
32. Scissors and knife.
33. Twine and pins.
34. Developing glasses.
35. Bottle of nitric acid for acidifying the bath.
36. Bottle of bichloride of mercury* for removing stains from clothing.
37. Towels.

* The sublimed mercury is excellent for this purpose, as it does not destroy color.

These should all be selected of the very best quality. It is poor economy for a photographer to attempt to save money on his chemicals. Aim for the best results, and to secure them use the best of everything.

For longer excursions, all the above articles should be taken along in duplicate, so that in case of loss they may be replaced, besides,

1. Scales with horn dishes.
2. Weights.
3. Nitrate of silver.
4. Sulphate of iron or sulphate of iron and ammonia.
5. Glacial acetic acid.
6. Pyrogallic acid.
7. Citric acid.
8. Plain collodion.
9. Iodizer.
10. Salts of iodine for sensitizing.
11. Alcohol and ether.
12. Nitric acid.
13. Rags for cleaning.
14. Cleaning vice.
15. Tools (screws, screw-driver, diamond for cutting glass).
16. Permanganate of potash for restoring the bath.

The quantities of the articles must depend on the length of the excursion. For excursions it is to be recommended to test all the mixed chemicals at home, and only to take them when they are in perfect working order. All the articles should be compared with the list before starting, as it often happens that thoughtless people arrive at their destination and have to go home again because some simple article was left behind.

That working in the field or tent requires much more circumspection than in the atelier is self-evident. The difficulties become sometimes insurmountable. Dust, heat, and the want of suitable water, wind, cold, and unfavorable weather. These very often put the patience of the photographer to the severest test.

Another point is of great importance, namely, solid apparatus which can easily be reduced to a small compass. I will describe some such here.

Landscape photography is considerably more convenient with dry plates. These require the articles from 2 to 7, also 12 of the first list; a dark-box to change the plates; instead of the latter, several holders, one plate in each holder. Of course, the results of the dry process are not of such a character that they can be placed alongside of the wet process. In the latter the result can be known very readily, and if not satisfactory the negative can be retaken, while in the dry the result is first found out at home.

Meagher's Travelling Camera.—This camera* (Figs. 87 and 88) which was first constructed by a celebrated joiner, consists of a rigid front piece, *v*, which is supplied with grooves for the reception of the board carrying the tubes; the back-piece, *H*, *H*, is movable, and receives the ground-glass and plate-holder. The focussing is done by the screw adjustment, consisting of an endless screw, *s*, *s*, and the

FIG. 87.

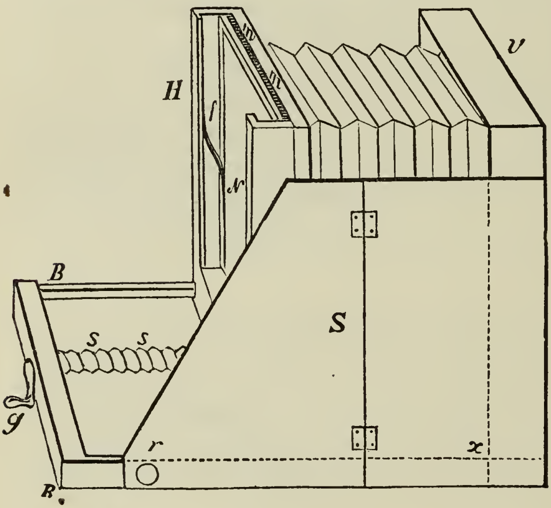
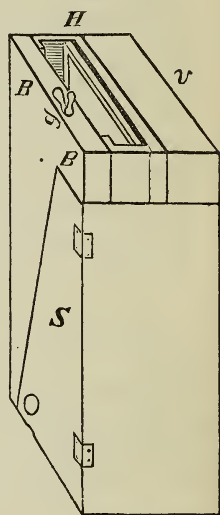


FIG. 88.



handle, *g*. The camera board, which carries the whole arrangement, is divided; the back-piece, *B*, *B*, is at *x* connected with the front by hinges; a folding support, *S*, with a screw, *r*, gives firmness to the whole. For the transport, the bellows is screwed together, so that *H* and *v* touch each other.

The board, *S*, is turned over, and fastened with the screw at *r*. Meagher, as well as the American Optical Company, furnishes square as well as rectangular cameras; as the first only use lengthy plates, we see no advantage in their use. The camera of the author can be used for plates 9 x 7″, and for a focus of from four to twelve inches; has a movable partition in the centre for the production of stereoscopic pictures, and served five years ago in the Egyptian expedition with

* The same and similar constructions are furnished in America by the American Optical Company in New York, one of whose boxes I have had great pleasure and satisfaction in using.

the best success. The only inconvenience is want of firmness of the piece S', which is apt to shrink and burst in very dry weather. To this camera also belongs, besides the ordinary, a *double* holder, intended for dry plates. Camera holders and objectives we generally transport in a large tin chest, which is closed with a strap. One man carries, by means of a strap or rope, the chemical box in front, and the tin chest on his back, while a second takes the tent with tripod on his back. In this manner the author has made the most impassable mountain tours. The tripod should be solid, so as not to shake in the wind. For silvering, we prefer a Japanese dish having a tight-fitting lid, so that nothing injurious may splash into the silver bath.

Others take a travelling bath-holder. This article, to be had of all dealers in photographic goods, consists of an ordinary glass bath-holder, packed tightly in a wooden box, with lid lined with soft india-rubber, which can be closed tight by means of a screw. For short excursions this arrangement is practical. In long excursions the india-rubber is apt to act prejudicially to the silver bath. For objectives different instruments are used. For instantaneous pictures portrait tubes are used, and single landscape lenses if a little aberration does not matter. Triplets and aplanatic, if correct lines, etc., are desired; wide-angled and pantoscope, if a large field is desired. (A summary list of the size, focus, size of field, and price of these instruments, is found in Vogel's Pocket Reference Book, published by Benerman & Wilson.) The large field of the latter can very often have an annoying effect, when indifferent objects in the foreground are brought into the picture, which, by their large appearance, disfigure the picture, while the distance appears diminutive and small. (See chapter on Perspective, Part III.) Often the main object in a landscape lies in the distance, then a long-focussed lens should be used, which produces the distant objects large. The author always takes three objectives with him, a pantoscope, whose length of focus is half as long as the size of the plate; an aplanatic, whose focus is nearly the length of the plate; and an aplanatic, the focus of which is $\frac{4}{3}$ $\frac{3}{2}$ the length of the plate. When arrived at the spot, he tries which objective produces the most favorable picture. About the point of view, etc., see part on Æsthetics. About annoyance by the public, see next chapter. The methods of operation do not differ from the former described. We use, on account of its keeping qualities, on journeys, the equivalent collodion, the sulphate of iron and ammonia (for developing and intensifying), and for fixing, on account of its rapid action and easier washing, cyanide of potassium. The last drop of water off a plate after fixing, caught on the tongue, will disclose

by its bitter taste any insufficient washing. If the time or water is short, the plates are developed and intensified, put in the plate-box without fixing, and finished at home. Albumenized plates are advantageous.

SECTION V.

ARCHITECTURE AND INTERIORS.

Pictures of buildings, out and indoor views, present difficulties through the point of view. There is not sufficient distance, for instance, in a narrow street to bring a building, or a part of it, into the field of view of the camera. Further difficulties present themselves in interiors by insufficient lighting. In this case long exposure or reflected sunlight will help. (See remarks thereon.) A not very slight difficulty consists here, as well as in landscaping, *i. e.*, annoyance from the public. In taking streets, persons often push forward in an improper manner, taking a stand immediately in the foreground. It is, therefore, often impossible to make an exposure. If it is an affair of two or three persons, a little ruse, or a talking will help to get rid of them, and place them in a position outside of the field of view. With large masses in streets this will not answer. It is well to be as little observed as possible. Either place your apparatus at a window in a room, to hide it from the gaze of the public, or place it in a covered furniture wagon, in the side of which a hole is cut for the objective. The wagon can be properly placed without notice from the public. As objective use only the pantoscope (for large angle), showing correct lines; triplets or aplanatic for smaller ones. About the most important point, perspective and point of view, see the third Part of this book.

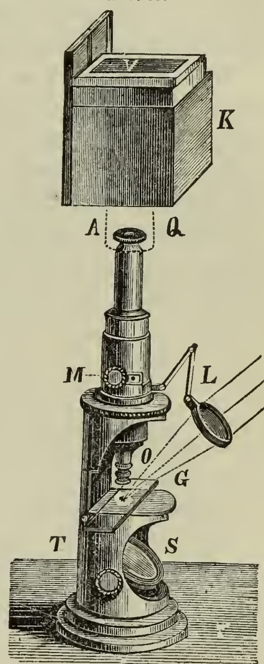
SECTION VI.

MICROPHOTOGRAPHY.

The enlarged photographs produced from microscopic objects are called microphotographs, to distinguish them from the microscopic pictures of large objects, which are called microscopic photographs. The latter are entirely out of fashion. Formerly they were an important article of trade of the house of Dagron, in Paris, who also sold the apparatus for the production of the pictures. They contained a lens combination of very short focus, which was placed on a small

camera with a movable holder. This holder could be moved ten times, and produced from a negative small transparent positives, which were cut apart, then provided with a magnifying glass, and were ready for the trade. During the siege of Paris, Dagron produced microscopic dispatches on collodion, which were stripped off with so-called leather collodion, and hundreds of them placed in a quill and tied to a carrier-pigeon. In this way Paris communicated photographically with the outside world. Here we busy ourselves only with microphotography, which is of some importance to the naturalist, physician, and an aid in instruction of great consequence. Microphotographs are best made with the aid of an ordinary microscope, of the same kind as used by the searcher in making his observations. The less there is altered on it the better. The simplest manner is that of the author's. He places immediately on the microscope (Fig. 89) a camera, *K*, with a landscape lens, *Q*, so that the objective of the camera nearly touches the ocular of the microscope. The camera is supported by a tripod of the required height. If the microscope can be placed horizontally the arrangement is still easier. If, with the aid of the concave mirror, *S* (attached to the microscope), the rays of the sun are thrown on the object, which is placed at *G* on a piece of glass, the picture can be plainly seen on the ground-glass. By the aid of the pinion, *M*, it can be set sharp; the photographic exposure can then take place, which in bright sunlight will be instantaneous.

Fig. 89.



This method of making microphotographs is so simple that any one can practice it who is at all familiar with photographic operations. It requires no other apparatus than a simple camera with a landscape lens. It can be adapted to any microscope which is sufficiently strong in light, and gives, accordingly as the ground-glass is more or less removed from the object, views which are equal, or larger or smaller, than the directly observed image.

Two precautions should be observed in making such pictures: The lens of the camera must not have a chemical focus, and the picture should be taken in a room which is not exposed to any vibration.

The picture may also be taken when the instrument is placed in a vertical position. In that case the camera must also be placed vertically in order that the two optical axes coincide.

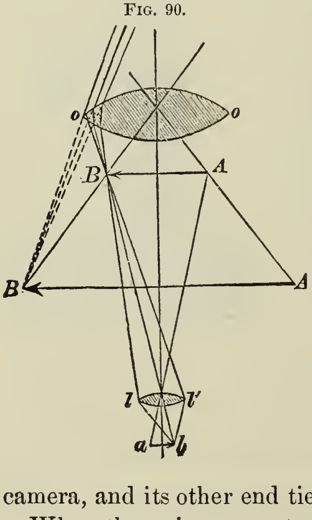
I published this method in November, 1862, and have frequently practiced it.

The illumination offers some difficulty in so far as a quantity of unnecessary light is easily thrown into the object-glass of the microscope, which materially disturbs the purity of the picture. The best way to concentrate the light is by placing the object at the apex of a cone of rays, the axis of which coincides with the axis of the microscope. With opaque objects this danger does not exist. The illumination is made with a condensing lens (bull's eye).

The above-stated simple combination of the microscope and the camera has the other advantage, that the cobweb lines are visible in every picture, and that a difference in the chemical and optical foci of the microscope itself does not amount to much, provided that the camera lens is free from this error.

But when the cobweb lines are not necessarily required, we can operate with the microscope alone. The microscope has two lens combinations, the objective lenses, *l*, *l*, which throw the enlarged picture, *A*, *B*, from the object, *a b*, and the ocular lines, *o o*, which again throw an enlarged imaginary picture of the object, *A*, *B*. If the ocular is taken out, and the lens, *l l*, is moved nearer to the object, the picture, *A*, *B*, will move outside of the tube of the microscope, and can be caught on a ground-glass. The objective of the microscope can also be used as a photographic lens. The lens of the camera, *K*, Fig. 89 is removed; the tube of the microscope, after having removed the eye-piece, *A*, is placed in the opening of the camera; all extraneous light is excluded by means of a cloth, or a sleeve, which is nailed on to the camera, and its other end tied to the tube of the microscope.

Fig. 90.



When the micrometer screw, *M*, of the microscope is now gently turned in a direction to remove the object from the object-lens, the image will appear on the ground-glass as the image produced by the objective of the microscope is enlarged and projected on the ground-

glass by the eye-piece. Unfortunately a chemical focus becomes rather annoying with this method.

Now there is a third method, without changing the microscope (ocular included), to produce pictures on the ground-glass. The ocular end, *A*, is placed in the camera, *K*, Fig. 89 (after removing the tube of the camera); now carefully turn the screw, *M*, so that the tube of the microscope will move away from the object, thereby the enlarged picture, *A B*, will move away from the ocular, coming in its focus. A picture suddenly appears on the ground-glass, *K*, since here the picture thrown by the microscope objective is enlarged by the microscope ocular. The exposure is done in the usual manner.

By removing the ground-glass further from the object, we enlarge the image.

The extent of the chemical focus is easily ascertained.

I employed a microscopic photograph by Dancer of Konigsberg. The picture itself was an albumen positive, about the size of a pin's head, and placed between thin glass; under a microscope with a power of one hundred diameters, it appears as a plain, legible inscription—the inscription on the tombstone of General Dickson—which is arranged in about the following order:

(1) To the memory of
(2) William Francis Dickson,
(3) Major in Her Majesty's 62d Regiment
(4) of Foot, and eldest son of
(5) General Sir Jeremiah Dickson, K. C. B.
(6) He died a soldier's death before Sebastopol,
(7) June 8, 1855, having been killed early in
(8) the morning of that day, whilst gallantly
(9) holding the quarries against repeated
(10) attacks of the Russians, etc., etc.

I laid this photograph on the stage of the microscope, not flat, but inclined by placing pieces of wood under one end. The direction of the lines remained horizontal, but the line vertical to it formed with the horizontal plane an angle of 30°. By this arrangement the distance of the lines from the combination of lenses was a different one for each line, and it was not possible to focus sharply more than one or, at most, two lines. With the Schick combination of lenses, 1 + 2 + 3, I focussed sharply on line 8, and took two pictures. On both pictures line 5 appeared black and sharp instead of line 8. This demonstrated a chemical focus. To measure this difference, and to compensate for it, I used the micrometer adjustment of Schick's instrument,

by which the stage of the instrument can be elevated or depressed, and by which the fine adjustment is made.

From the above experiments it becomes evident that in order to obtain a sharp picture of line No. 8, I must focus on line No. 5 ; or if I focussed on line 8, I must turn the micrometer screw until line 5 appeared sharply defined in the field. I have measured the revolutions, and found that with G. Rose's microscope it amounted to 50°, and with Dove's microscope to 35°, for the combination 1 + 2 + 3.

These measurements are easily made by placing under the head of the micrometer screw a paper circle, which is divided by radii from 5° to 6°, in such a manner that the centre of the circle coincides with the prolongation of the axis of the screw, and by filing on the head of the screw a line with a file. By placing the eye vertically over the head of the screw, it is not so very difficult to note the change on the divided paper circle.

After having measured the focal difference, two new pictures were taken; line No. 8 was sharply focussed, the micrometer screw was sufficiently turned to compensate for the chemical focus, and now line 8 appeared sharp in both pictures.

Another picture of the whole slide placed horizontally and taken with a magnifying power of 25 and the above correction gave a sharp picture of all the lines.

With the microscope the focal difference of every combination must be ascertained by experiment. For low powers the difference is small; a six-fold magnifying power (lens 1 of Schick) shows scarcely any chemical focus.

Benecke and Woodward use a solution of sulphate of copper and ammonia to keep out the difference of focus. This solution will only permit the passage of blue rays. If this solution is placed in a glass-cell before the collimator lens, the focus can be taken without fear of a chemical focus. Woodward also uses artificial light for lighting magnesium and electric. He recommends the latter.

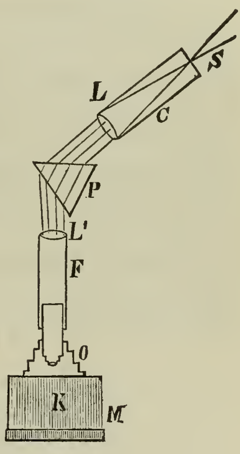
SECTION VII.

SPECTRAL PHOTOGRAPHY.

It appears almost an idle task to speak of photographing the spectrum, and yet it is of immense importance, not only for the spectral analyzer, who through it obtains a true picture of the spectral lines

of the sun, which serve as a vehicle for the determination of matter,* but also, from the latest observations of the author himself, for the photographer, for by spectral photography the author was led to make the discovery, that there are expedients existing, to make bromide and chloride of silver sensitive to light in the red and yellow rays, which have hitherto been considered chemically non-actinic. By spectral photography, the author further was enabled to make studies on the striking changes in the transparency of our atmosphere, for chemical actinic light of different colors (see February number, 1874, *Photo. Mittheil.*); further, about the effect which the different preservatives and organic substances have on the sensitiveness of the plates. For the production of a spectrum, a spectral apparatus will answer, which consists of a tube, *C* (Fig. 91), in which are set two metal plates, *S*, allowing a slit between them, which can be widened or narrowed with a screw. This slit is exactly in focus with the lens, *L*, whose task is only to make the rays parallel issuing from the slit, and to throw them thus on the prism, *P*. This separates each ray into a color fan, so to speak, and such are taken up by the telescope, *F*, the lens of which, *L'*, unites the various colors, each for itself, and thereby a real color picture is formed in the focus of the lens. This lies inside of the tube. This color picture can either be observed through the ocular, *O*, or photographed. The camera, *K*, is placed for the purpose: place the tube in the opening for the tube, draw a sleeve attached to the camera over the tube to make it light-tight, and pull the ocular, *O*, out a little way; this produces the picture of the spectrum on the ground-glass. If sunlight falls on the slit, and it is sufficiently narrow, the dark lines can be seen. The narrower the slit the finer are the lines; the color picture is, however, dimmer. This method furnishes, with an ordinary spectral apparatus, pictures, in which the lines *D* and *G* (see figure), are about thirty-five millimetres apart. If larger pictures are desired, an apparatus with several prisms is used. The rays can also, in such cases, be photographed with the ordinary tube and camera, instead of the telescope. The longer the focus of the former the larger the picture.

FIG. 91.



* Details of the photographs of the spectral lines by Rutherfurd can be found in *Photographische Mittheilungen*, vol. 7, p. 222.

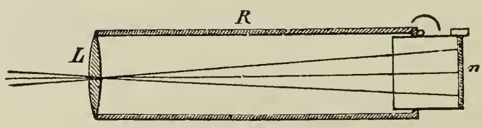
The parts PL and L' must be covered with a card-board covering to keep off all side-light. To make continued use of the sun, a heliostat must be applied which follows its course. The cheapest can be procured of Spencer, in Dublin. The price is fifty Prussian thalers. The processes used are the ordinary; bromo-iodized collodion is, however, only sensitive to the green. For taking the yellow and red parts, bromo-silver dry plates must be used (see *Photo. Mittheil.*, 1873, December number.)

SECTION VIII.

ASTRONOMICAL PHOTOGRAPHY.

The photographing of stars has already obtained universal application; 1, To study the changes on the sun's surface; 2, To fix the phenomena during a total eclipse of the sun; 3, To obtain true pictures of the moon's surface; 4, Taking of stars and groups of stars, in behalf of exact measurement, which can be accomplished more easily on the photographic picture than in the telescope. Of course, when such measurements are required, a very accurate adjustment of the instrument, and freedom of focal difference are necessary. Simpler arrangements will answer, if only pictures of the protuberances and corona are desired. The astronomical telescope is, according to the main point, a long tube with an object-lens L (Fig. 92). This will throw a

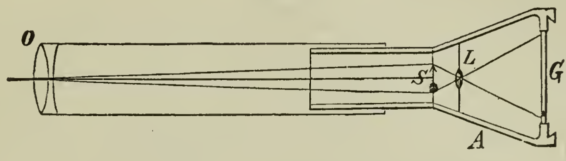
FIG. 92.



picture in focus of a very distant object. The longer the focus the larger is the picture. The picture of the sun in a telescope of six feet focus is as large as eight lines. This picture is either taken direct, if the object shows weak illumination, or trembles slightly (picture of the eclipse of the sun, the stars, and the moon), by placing the sensitive plate in the focus, or the small picture is enlarged direct by a small lens, L, of short focus (Fig. 93). The focussing is done at G by means of the ground-glass. In this manner, pictures enlarged six times can be produced very easily by momentary exposure. With objectives of weak illumination the exposure is longer, and as the stars move, the telescope must follow their course; it must have an equatorial stand, *i. e.*, by means of exactly constructed clockwork, to turn on an axis,

which is parallel to the axis of the globe. What is necessary to observe, for very accurate work of this kind, is described by Rutherfurd, the excellent American star photographer, having the projected ob-

Fig. 93.



servation of the transit of Venus in view, which, if accurately measured, will give the means of determining the sun's distance from the earth. Such accuracy is not necessary for the taking of ordinary sun spots. Rutherfurd says:

1. Objective.—The objective is adjusted according to the chemical focus without regard to the visible picture. I have done this in two ways: first, by a combination of crown and flint glass, with the corresponding curves to produce this correction; second, by placing to an ordinary achromatic objective, a lens with such curves and such density as appeared necessary for the desired correction. The objective of fourteen-inch opening, which I described in the May number of *Am. Jour. of Science*, 1865, was constructed after the first plan, and is now in possession of the National Observatory of the Argentine Republic.

The thirteen-inch objective, which is at present in my observatory, was made according to the second manner. Without such exact correction the photographic picture will not appear sharp, and consequently be useless for scientific purposes.

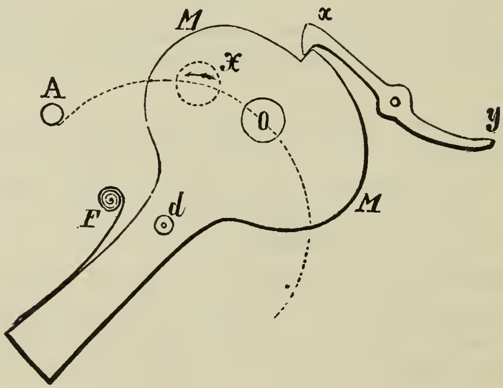
2. Tube and Focus.—With an objective of the above description it is impossible to focus with the eye; at all events such a focus is too uncertain, if great precision is desired to depend on it. The focus must be found by trials; a micrometer screw must be also attached in such a manner that when set it can at any time be reset. Wooden tubes are, on account of uneven expansion caused by moisture in the air, not to be recommended. I make use of galvanized iron, varnished and furnished with three thermometers. According to the degree of heat recorded by these, the expansion of the iron is calculated, and the focus reset by means of the micrometer screw.

I find that the stars are the best means to determine the focus accurately. Take on one and the same plate, one picture after another of one and the same group of stars, moving the plate after each ex-

posure, and judge from the result, in which position the sharpest picture was obtained on the plate. This point is marked and taken as the focus. If the experiment is repeated in a clear atmosphere, and the same focus found, it can be taken with regard to the temperature of the apparatus as certain and correct.

3. Camera.—The placing of the plate in the camera is as usual—by means of a holder. A photographic picture of the sun has a diameter of about one-tenth of an inch for each foot of focal length. The picture of the sun, as it appears in the focus of the objective, is enlarged by means of an ordinary objective (for my telescope I use a quarter-size Harrison portrait tube). There could be by all means better objectives made, aplanatic, and for the chemical rays corrected, while the best portrait objectives show decided curves, or have a focus which is about midway between the optical and chemical, whereby a part of the sharpness is lost on each side. Until now I have not seen a lens such as I mean (Steinheil, in Munich, and Schroeder, in Hamburg, have constructed such). There, where the rays cross each other, *i. e.*, in the principal focus, the simple instantaneous shutter, *M*, is placed, *i. e.*, a plate rotating around *d*, having an opening at *O*. This is held by the hook *x y*. If this is pressed at *y*, the spring *F* will

Fig. 94.



force it past the opening of the enlarging objective, and thereby cause an instantaneous exposure. In the camera, directly in front of the exposed plate, is a very fine platinum wire, stretched from east to west, with a simple attachment, by means of which it can be made to follow the course of any star or any sun-spot which, in consequence of the rotation of the earth, crosses the field of view. The shadow of this wire marks itself on the photograph as a very fine line, and shows

if rightly adjusted the zero-point of the position (Vogel, in Bothkamp, has another arrangement to determine the position). This of course, providing that the equatorial apparatus is adjusted to the meridian and height of the poles, finally corrected for the breaking of the rays, in case the pictures should not be meridional. Back of the ground-glass is placed, by means of a sled, moving easily from east to west, a Ramsden loop, with which the whole plate can be overlooked from one side, to determine (about which we will speak hereafter), the angle for any great extension of the plate. To avoid unnecessary marking of the picture, the following adjustments are necessary:

1. *Adjusting the Objective.*—This is accomplished by means of screws, which penetrate through the rim of the objective, and are turned and adjusted until the reflections in the objective of the flame of a candle, held at a small hole in the holder, fall on top of each other, as soon as it can be sighted through the blue part of the flame.

2. *The Adjustment of the Plate.*—This is more important than the former, and is accomplished by means of screws placed in the back part of the camera, where the holder is placed. The operation is the same for every holder. If it is, however, adjusted to the one furthest from the objective, the enlarging objective must be removed during the adjustment. A plate of ordinary glass is placed in the holder, having the side turned away from the objective smoked, to prevent reflection; the other side is covered with a piece of dull black paper, having a hole a quarter of an inch in diameter in the centre, so that only a small spot in the direction of the optical axis is left uncovered. The objective is closed with a lid, which also has a hole a quarter of an inch in diameter in the centre. A candle is now held before this hole, and the screws operated until the flame can be seen in the uncovered part of the plate. This indicates that the plate is at right angles to the axis of the telescope.

3. *Adjustment of the Enlarging Objective.*—This also is done by means of particular screws, which are operated until the different reflections of a candle-flame, which is held before a small hole in the centre of the lid of the first objective, appear one above the other by sighting them through the blue part of the flame. The size of the unavoidable aberration of the enlarging objective can be determined by two methods:

First Method.—Place in the focus of the objective an even parallel glass plate, on which a fine-lined net is engraved. Then point the instrument towards the sky, and make an enlarged picture of the line-net. The net and the enlargement are accurately measured,

which measurement will conclusively show the aberration of the enlarging objective.

Second Method.—In the place of the plate intended for the picture an even glass plate is placed, having a number of parallel lines, in the direction of north and south, and about three minutes, equatorial time, apart. Then set the telescope immovably near the meridian, and close the light-opening to about one inch. By this reduction the picture of a star can be seen quite plainly, notwithstanding that the objective is adjusted to its chemical focus. The transit of the various bright stars through all the lines of the plate must be observed, with the aid of a chronometer, through the loop mentioned above. A comparison of the transits with the measured distances of the lines from each other will not only show the angle-value of a known length on the plate, but also the size of the aberration produced by the instrument, objective, and enlarging lens combined.

Another method to determine the angle-value is to photograph an object, the distance of which is known, *i. e.*, a building during the day, or two electric lights arranged for the purpose at night, or a group of stars, for instance the Pleiades, the distance of which is very well known, whereby with accurate measurement the desired value can be ascertained. In my opinion, the angle-value of a given length on the plate can be ascertained by a combination of these methods with such accuracy, if it is not perfect, however, surpasses that by means of line cross micrometer or in fact all astronomical measures.

In behalf of pictures of the sun I would mention that the edge of the sun cannot be used for measurement of certainty. A photograph of the sun appears at times larger, then smaller, according to the intensity of the rays which produced the picture. The cause of this irregularity is change in size of the light-opening of the objective in the time of exposure, transparency of the atmosphere, the time of day, or the too great sensitiveness or insensitiveness of the chemicals. The sun has generally no sharp positive outline, but is in the most auspicious case an irregular, boiling, eternally restless object, not at all suitable for a starting-point in an accurate measurement. While in all optical measurement we are confined to a small part of the sun's edge, photography produces the whole of the sun's surface. It can, in regard to the average condition of the outline, be accurately centred, and permit in this manner of more accurate measurement.

In photographing the transit of Venus, the picture of Venus will certainly appear sharp, facilitating easy and exact measurement. Its position, however, must be determined from the centre, and not from the edge of the sun.

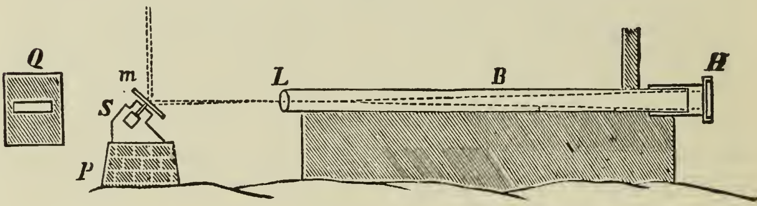
In photographing fixed stars the following must be observed: A good objective, set in an equatorial telescope, which is moved by a correct-going clockwork, produces, by short exposure, the pictures of large stars as small round spots, which can only be seen by means of a loop. In longer exposures the size depends finally on the more or less vibration of the atmosphere, which is also the cause of the flickering and twinkling of the stars. With eight minutes' exposure stars of the ninth magnitude are photographed. These are ten times weaker than the weakest which can be seen on a clear night with the naked eye. Their pictures appear as very small spots. It would be very hard to discern these from dirt-spots on the plate. *The telescope is therefore placed in a different position* after the first exposure, and a second exposure made, also of eight minutes, the clockwork in the meantime being kept in motion, to lead the telescope in the right direction. There will be on the plate two pictures, close to one another, of each star, distance and relative position being by all the same. These double pictures are easily found on the plate, and as such discerned from dirt-spots. When the telescope stops, the pictures of the stars will certainly make a movement. Bright stars will therefore produce stripes or streaks, like walking persons in a landscape. This streak is of great importance to determine the direction from east to west on the plate. For dim stars, which leave no trace of a streak, a third exposure is necessary to determine the direction. This is done after stopping the telescope a few minutes.

The polar axis of the telescope has, if ever so nicely and carefully balanced, a certain degree of resistance to the movements, therefore the clockwork to move it, to produce an even motion, must be of a peculiar and exact construction. If the picture of a star moves during the exposure it will not appear round but oval. As the measurements must be determined from the centre of the picture, it must be completely round. The movement of the stars is, moreover, not fully regular, to be sure, in consequence of the breaking of the light by the atmosphere. The light coming from a star is led away by our atmosphere, the star appearing higher than it is in reality. This difference between appearance and reality is in no manner regular, it changes continually in the up and down movement of the stars; it can be computed, however, after a somewhat complicated rule for each star, according to its height above the horizon. The clockwork in motion for a telescope can only be adjusted for a regular motion; the time, therefore, for a photographic exposure must be chosen that the breaking of the light with the star in question is as nearly regular as possible for eight minutes; the rapidity of the clock must be regulated

accordingly. In this manner the movement of the picture of the star can be reduced to less than one ten-thousandth of an inch during an exposure of eight minutes (Schultz-Sellack, *Photographische Mittheilungen*, 1873, p. 200). A great obstacle for accurate measurements on photographic plates is the contraction of the collodion film. The picture has when wet, according to Paschen, different dimensions than when dry, and therefore recommends the placing of a glass micrometer plate in the main focus, in which lines are etched crossways at exactly equal distances from each other. These are photographed along in the enlargement, and as the distances are known, the position of each point can readily be determined, no matter if the film shrinks or not. In exposures with the main focus this method is not applicable.

A peculiar manner of photographing the sun is practiced by Winlock, in Boston. He has a stationary telescope, *B*, Fig. 95, with a

FIG. 95.



lens, *L*, of forty feet focus, one end being in the dark-room, where is placed the holder, *H*. In front of the telescope is placed a heliostat, *S*, with reflector, *m*, which throws the rays of the sun on the lens. A board, *Q*, is held in front, and rapidly moved across, thereby causing the exposure. (See *Photographische Mittheilungen*, vol. vii, p. 226.)

The English prefer, for their astronomical photographs, reflecting telescopes. Warren made his moon and eclipse pictures with one. The *wet* process and portrait collodion are generally used. H. C. Vogel, in Bothkamp, prefers, however, the dry process. He uses albumen plates according to an old formula given us by Fothergill. This is similar to the one given above of England's. The plates are rubbed over on the back with gum and lampblack, to prevent reflections from the back. The lower edges of the plates are ground straight. To fix this lower edge to the position of the sun, a piece of ground-glass, having its edges ground straight, is placed in the holder, so that it will rest firmly against two small pieces of glass placed there. The camera is turned until a picture of the sun's reflection is caught exactly on a line running parallel with the lower edge. If

the sensitive plate is placed there in the same manner, the lower edge will be parallel to the sun's movement. The instantaneous shutter is put in operation by means of a galvanic battery. (For further particulars see "Beobachtungen auf der Sternwarte zu Bothkamp," by H. C. Vogel, Leipzig, Engelman.)

In respect to the time of exposure in astronomical photographs, we would add that this depends very much on the transparency of the atmosphere. With an objective of one-twelfth relative opening, it needed five seconds for taking the protuberances of the corona, which is considerably dimmer, about eight times as long;* for taking the moon, five seconds (Rutherfurd in a clear atmosphere exposed three-quarters second for his moon photographs). All these exposures are applicable to the main focus of the telescope. Pictures of the sun need only momentary exposure, even in enlargements or dim-lighted telescopes.

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* In Syracuse, a photographic objective of three feet focus was used for photographing the corona, which, of course, will admit of quicker exposure.

THE ART OF PHOTOGRAPHY,

OR

PHOTOGRAPHIC ÆSTHETICS.

The photographic pictures which are obtained by the previously described processes are made for very different purposes. They are either of a purely scientific or technical nature, such as pictures of microscopic objects, representations of machinery or buildings, architectural plans, etc. In such cases their object is to instruct. Again, a real practical use is made of them when they furnish the basis for measurements, when used as aids in the construction of maps, or when buildings are erected according to the delineations which they represent. Finally, some of the pictures obtained are of an artistic nature, and then they have no other object than the one to please; and amongst representations from nature we have to class portraits and landscape pictures in this category.

The question whether photography is an art or not is an idle one.

Experience has demonstrated that a sharp and spotless, or in short a technically perfect photograph, be it portrait or landscape, may appear on the one hand untrue, or it may displease when the observance of the laws of the beautiful (which are the cause of our pleasure in the works of the plastic art or paintings) have been disregarded. That these laws in their generality are not applicable to photography, which more than any other art is "glued to the substance," is evident.

The photographer cannot follow his mind's ideal flight. The children of his creative fancy enchant us not in marble, nor do they charm us with brilliant hues on the canvas, but his aim is to portray nature; and the most which can be demanded of him is a beautiful reality,—truth in a pleasing form.

Let us see now how nearly photography gives us truth.

PHOTOGRAPHY AND TRUTH.

Admirers of photography assert so often that this young art represents the pure truth, the true counterpart of nature. Photography can, indeed, when rightly applied, produce truer pictures than any other art, but they are not absolutely true, and because they are not absolutely true it becomes important to learn the sources of error, and they are manifold.

Let us first consider the optical errors.

A picture which has been taken with a lens that does not delineate correctly, and causes the marginal lines which should be straight to appear curved, can certainly not be called a correct one. Many persons may not notice these distortions, nevertheless they exist. Some will say that a correctly drawing lens will avoid these errors. True, very true; but let us examine the pictures of high buildings which have been taken with such a lens from a low standpoint.

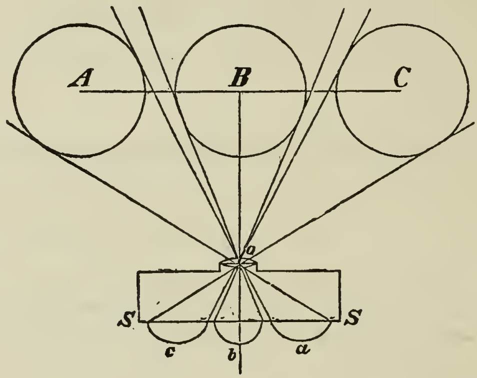
The lines which should be vertical will converge towards the top. Can this be called correct? But you will say the reason of this is that the camera was not placed level. Very good; but let us now try a Globe or Pantascopic lens, and take a view of a long street: how the perspective deepens; how enormously large the nearer houses appear, and how very small are the objects in the distance. Houses that are a hundred feet distant look as if they were half a mile away. Is this truth? No, certainly not; and yet the lens draws correctly, the camera has been placed exactly on a level, and the perspective is mathematically correct. A draughtsman could not make it any better.

But where lies the mistake? The angle of vision is too large. Unfortunately, this cannot always be avoided, and curious enough it affects straight lines as well as curved ones. Take, for instance, a pile of cannon-balls. An artist would represent the balls as circles. Now take a picture of them with a wide-angle lens, in such a manner that they will appear at the edge of the picture, and instead of circles we will have ellipses. Mathematically, this is easily explained. From every ball (*A B C*, Fig. 96), a conus of rays proceeds to the optical centre of the lens, *o*, and the plane of the picture intersects them as an ellipse, when it falls in any other direction but at right angles (see the chapter on perspective).

A photographer showed me the view of a castle which had been taken with a Globe lens. In front of the castle was a row of statues, and it was really comical to notice how the bodies and faces grew broader towards the edge of the picture, and the slender Apollo de

Belvidere, who unfortunately happened to be at the extreme edge of the plate, had such a broad face, and his body showed such a remarkable rotundity, that he looked like Dr. Luther.

Fig. 96.



Now, is this truth? Unfortunately these are not the only sources of error; there are a great many more.

Further on in this book, I publish four heads, portraits of the same person. They were taken by Loescher & Petsch, of Berlin, with front-light, top-light, side-light, and oblique-light. In the first picture the man looks dull and stupid; the second gives him an angry and savage expression; the third gives him a cunning look; which of the three named pictures is the true one? Not one of them. The truest representation is No. 4, where a combination of light effects has been employed, and we see that the mode of lighting can also become a source of error. This not only holds good for portraits, but refers to landscapes also. The view from the Rochusberg, in Bavaria, had often been described to me as most beautiful. Accompanied by friends, I visited the spot several times, but we could not see any beauty in the view. At last I visited it again, not as before in the morning, but in the evening, and then the view was charming. But besides the direction of the light being a source of error, there is another circumstance which has much influence on the correctness of photographic pictures.

Generally speaking *the lights are too white and the shadows are too black* in photographic representations. This is a radical error, which has its origin in the nature of the art, and the avoidance of which becomes sometimes very difficult. The error is most striking in taking the picture of an object on which the sun shines with full force, for

instance a statue. If we expose for a short time only we get the details of the light parts, but the shadow is a black spot without any design. If we expose for a long time we will get some detail in the shadows, but the lights will be over-exposed to such an extent that all the finer shades will be missing. Is this truth?

These are the reasons why we have so much difficulty in our studios when we wish to produce a properly lighted picture. We keep the lights more diffused and the shadows lighter than what painters would do, and the latter are often surprised when they see a model in the gallery, under such artistically faulty illumination, yield a picture correct in lights and shadows.

In taking landscapes, architectural objects, and particularly interiors, we cannot control the light with the same ease as in portraiture. I once photographed a chemical laboratory. The room was large, with an arched ceiling. In the picture you can see the tables, furnaces, retorts, lamps, etc., everything perfectly plain except the arched ceiling; this was too dark.

I made other attempts with twenty, thirty, and even forty minutes' exposure; at last I saw a trace of the ceiling, but now the objects near the windows were so much over-exposed that all the details were lost. The result was four pictures, not one of which was true. Finally I resorted to throwing reflected sunlight on to the ceiling.

This circumstance, that photography reproduces the dark parts too dark, makes itself felt in very simple operations, for instance in the reproduction of prints. A photographer reproduced Kaulbach's "Battle of the Huns." The copy was an excellent one, but the background was too dark, too thick, not hazy enough. The copy was refused, and another picture demanded.

The photographer now gave a longer exposure. The background had the hazy appearance of the original, but unfortunately the figures in the foreground, which should have been bold and black, had a dusky gray look. Is this truth? The artist succeeded finally by retouching the negative.

I have purposely selected simple examples to prove my assertion, that it is difficult to make truthful photographs. But now comes the worst point of all, the different colors. In photography the cold tones will be rendered too light, while the warm ones, such as red and yellow, will be reproduced too dark. As an illustration I may mention the photographic copy of Hildebrand's painting, "Sunset on the Ganges"—a glowing red sun with burning clouds of chrome yellow on an ultramarine blue sky. And now what does the photograph show? A black disk surrounded by black thunder-clouds. The sun looks

like the solar eclipse at Aden. Is this truth? Still more striking becomes the lack of truthfulness in photography when the artist attempts the solution of a higher artistical problem. Perhaps the reader knows the pretty little picture called "A Mother's Love." A young mother, in modern costume, sits in an arm-chair reading; her little son approaches from behind, and, standing on a chair, embraces her. Surprised and delighted the mother drops her book and kisses the child.

A photographer took it into his head to reproduce the picture from living models. He easily found a pretty girl suitable to represent the mother. A boy, a chair, some decorations, and furniture, were not hard to procure, and the group was placed in position. The mother in effigy readily complied with the directions of the artist, and made a face which perhaps might express motherly affection. The boy, however, had different ideas. He did not feel himself drawn towards his pseudo mother, and protested energetically against any familiarity. It required a good sound thrashing to bring him to terms. With these preliminaries time had been lost. The mother begins to feel uncomfortable in her forced position, with the head partially turned backwards, and finally the photographer "fires away." The picture is sharp, fully exposed, without spot or blemish. The models, to their great joy, are discharged. A print is made, and what is the result? The boy embraced the mother with a face in which the thrashing is plainly visible, and with a look that seems to indicate a desire to choke her, while the mother looks much more like saying, "Charley, you are very naughty to interrupt my reading," instead of "Dear little pet." Can any one say that such a picture expresses the intention of the photographer? Is the above-described an expression of the title "A mother's love?". Any one will fail to see the intention of such a picture. The whole, although a true copy of the group as placed before the camera, is, as an expression of a mother's affection, a photographic lie.

Such pictures we find by the thousand. Ten years ago these sins were committed over and over again by the makers of stereograms, and when such pictures meet with approval we can only blame the corrupted taste of the public for it. But it will be said that the photographer cannot be blamed for the lack of truth in such a picture. His models should be censured for it. Still it is the fault of the photographer. Pictures in which the models do not absolutely come up to the intentions of the artists should not be made at all. They do not lie within the province of photography.

But there are other characteristic cases of photographic untruth for

which the models cannot be blamed. Stimulated by the beautiful pictures of Claude, Schirmer, or Hildebrandt, a photographer attempts to take a sunset. Of course the brilliant glowing sun requires only a very short exposure; what kind of a picture will he get? A round, white spot surrounded by some glowing clouds will be all that is visible. All the objects in the landscape—trees, houses, men—are all totally under-exposed. The road, the village, the wood, and the meadow, all so beautiful to the eye, are nothing but a confused black mass without any outline. Is such a picture true? Even the enthusiast in photography will not dare to say yes.

Cases where glaring contrasts in light and shade make the production of a true picture impossible are very numerous. Most of the photographs of the Royal Monument in the "Thiegarten" belong to this class. The monument is beautiful, but the background of the trees is without detail, without half tones, an undefined mass, anything but a representation of the splendid foliage which charms the eye at this spot.

Still more numerous are the photographs of rooms, where the corners in which objects are plainly visible to our eye are represented by pitch-dark night. Other cases of photographic untruth are still more characteristic.

Observe that mountain scene. A village inclosed on either side by wooded hills occupies the middle ground. Houses are picturesquely scattered amongst the trees on the hillside. A chain of finely curved mountains in the distance, the peaks of which are glowing in the evening sunshine, forms the background of this wonderful picture. Only one thing is annoying. A dilapidated pigsty, and next to it a heap of straw, are in the immediate foreground. A painter who would paint this picture would either omit the objectionable feature altogether, or keep it so subdued that it would barely be noticed.

How is it with the photographer? He cannot remove the sty. He looks for a different standpoint; but now the trees cover a large portion of the landscape. He takes the view, sty, and all, but what kind of a picture will he get? The sty, which is in the immediate foreground, on account of its proximity, appears of gigantic size. The distant landscape, the *main object*, is small and insignificant. Still worse is the effect of the pile of straw in front of the sty. It occupies one-fourth of the whole composition.

Being the most brilliant object in the whole picture, it draws at once the eye of the spectator and calls it away from other more important points. The effect is unpleasant. It annoys the photographer, and does not appear to be a representation of the landscape for which

it was intended, but a picture of the pigsty. The secondary matter has become the main object, and if any one writes under such a picture "A View of Dornburg," it is simply untrue. It is untrue, not because the objects represented do not exist in nature, but because the secondary matter is represented too plainly, too glaring, and too large, and the principal objects appear dim and unimportant.

We now touch a sore spot in photography; it draws the main objects and secondary matters with equal distinctness. To the plate everything is indifferent, while the true artist, in producing pictures of nature, will give prominence to the characteristic points, and subdue and moderate the secondary matters. With artistic freedom he can act and do as he feels best, and he is fully justified in doing so; for as he gives the characteristic points only, and suppresses what is secondary, his work will appear more true than photography, which reproduces everything with equal distinctness, and sometimes gives the greatest prominence to the most trifling matter.

Reynolds, in speaking of the portrait of a lady, where an elaborately painted apple tree forms the background, says, it is the picture of an apple tree, and not of a lady. The remark is applicable to a great many photographs. It is a cardinal fault that they elevate secondary matter to the most prominent position. We see a conglomeration of bright furniture, and only on close inspection we will find that a man is placed amongst it, for whose portrait the picture is intended. We notice a white-spotted dress, and finally discover that it belongs to a girl whose head is just visible. We see a park with fountains and other fixings, and on very close inspection we notice the black coat of a man dimly contrasting with a piece of dark shrubbery.

Perhaps some will raise a great outcry when I ascribe greater truthfulness to the unrestrained art of painting than to photography, which generally is considered the most truthful of all the picture-producing methods. That I refer only to the works of first class artists is a matter of course, and it is one of the greatest merits of photography that it has made the daubs of art, which were formerly sold at every corner, an impossibility. I consider it my duty to call attention to the sources of untruth in photography. Only when we have learned to know them, and to appreciate them, will we learn also to avoid them; and those who have been taught to watch for them feel surprised and astonished how problems of the most simple nature offer difficulties in regard to truth.

It is the duty of the photographer to weigh all the difficulties which he has to encounter in the production of a truthful picture. His pic-

ture to be true must give prominence to the characteristic points, and such as are secondary must be made subordinate. The insensible plate of iodide of silver cannot do this. Controlled by immutable laws, it delineates everything that is presented.

The photographer accomplishes his purpose partly by a suitable preparation of the original, partly by a proper treatment of the negative. It is necessary, however, that he should know the characteristic and secondary points of his model. He that has not got an eye for these is not a photographic artist.

As the sculptor and painter, in order to produce a lifelike and beautiful picture, must pay attention to the minutest details of every feature of the face, every effect of light and shade, every fold in the drapery, so must the photographer study his model as closely as possible in features, carriage, and dress. The forte of the two arts, painting and photography, is however entirely different.

The object of both is to produce a beautiful picture on a plane surface, which must not appear flat, but round and real.

The painter can produce upon his canvas from an imperfect model an artistically beautiful picture, and improve upon the original by idealizing. The photographer has to work differently. He cannot, like the draughtsman, make changes in his picture (a few trifles excepted). To secure beauties in his picture, they must be present in the original. It is therefore his object to beautifully pose and light his model, and in short to arrange a living picture. Not until this has been done is the mechanical process put into operation. It is by no means true that only beautiful originals will furnish artistically perfect pictures. Every original has its faults. The photographer must reproduce his original from the point where it shows the least faults, or he must cover them by artifices. If he fails in this, the very best of chemicals, apparatus, and formulæ, will fail to produce an artistically beautiful picture.

ON LIGHT AND ILLUMINATION.

Light is the element of life, the drawing-pencil of the photographer. It is the brush with which he paints. For him a thorough knowledge of this element is as important as it is for the painter to possess an exact knowledge of his colors.

The physical principles of illumination we have already explained in the second part. We would refer to these, that a judgment may be formed of the strength of light under different circumstances. Here we have it with the æsthetic principles of illumination. In the former chapter we have made the presupposition that, with the drawing arts, it is possible to obtain a true picture of nature. We must here make another restriction. In fact, not a single picture is true; it only appears so. The artist who paints a sunset scene, paints the sun, perhaps, with vermilion and white. These colors have not near the brilliancy of the setting sun, which is at least a hundred thousand times lighter, nevertheless such a true colored sunset makes a fabulous true impression. The cause lies here in the effect of contrast. A gray paper appears dark on a white ground; on a black, however, light, much lighter than it really is; for this reason, the red sun appears lighter through contrast with the heavily shaded objects. These effects of contrast also help in photography. An under-exposed picture, when printed plain, produces a chalky-white face; in like manner, washed goods, aside of a deep black coat. If the coat is covered with india-ink, so that it will print gray, the face will not appear so white. In photography, we have as the lighter white, the paper; the deepest black, the dark surface of albumen colored by light. Between both extremes, we must keep the choice of the tones, which shall appear in the finished picture; the richer these gradations of tone are, the pleasanter our eye is impressed. Conditions are that, what appears lighter in nature, must also appear in the picture lighter; the darker, also darker in the picture. The numberless delicate tone gradations of nature are in this case for the educated eye the only guide; they cannot be produced absolutely true, but very nearly so.

Like the painter or draughtsman the photographer has for his purpose the production of a picture on a plane surface which shall give the beholder the impression of a reality. The figures must not appear flat like the paper which bears them, but plastic, with foreground, middle, and background.

There are two ways of producing this apparent solidity. The first of them is by means of *perspective*.

All objects of equal size appear smaller in nature when seen at a distance; the draughtsman, bearing this in mind, decreases the proportions of his figures with the distance. He succeeds thus in producing the impression that the objects are both near and distant, although all the figures in his picture are equidistant from our eyes. Pictures, in which these laws of perspective have been neglected, for instance, old pictures of Van Eyck, Kranach, etc., appear flat. Hence arises the importance of a knowledge of perspective both to the painter and draughtsman.

The second method of giving a plastic appearance to flat objects is the proper distribution of light and shade.

We draw two right-angled triangles alongside each other, and both will appear as flat figures. As soon, however, as we shade the one with india-ink, so that the shadow will gently decrease from the side towards the centre, the triangle, although always remaining a plane, will appear like a cone, and on the other hand round objects will often appear flat when these contrasts of light and shade are wanting.

The principal method of making plastic pictures is, therefore, by the proper employment of contrasts, and the artist has them in his power, but he must know how to use them. We will now proceed to the special consideration of these contrasts.

Let us consider first the raw material with which we paint,—the light. This ink, in its original purity, is so powerful that we cannot work with it in our studios when we wish to produce real half-tones. In direct sunlight we will get a portrait glaring white on one side, and sharply defined, not gently shaded, and black on the other.

Even when the sunlight does not strike the model directly, the reflections from windows and other objects would become a source of great annoyance. Even curtains afford only a partial protection against this direct sunlight. A considerable portion of it penetrates, destroys the shadows, and makes the picture weak. For this purpose we not only exclude the direct sunlight from the model, but also from the atelier itself, by making the latter face towards the north. We go further and construct sunshades, working only with the diffused light of the clear or cloudy sky.

While, generally speaking, the rays of sunlight may be considered as being parallel, those which emanate from the sky take all possible directions; horizontal when they come from the horizon, vertical when they come from the zenith. These circumstances are important. While in consequence of the parallelism of the sun's rays, a body on which the sun shines will show sharply defined contrasts of light and shade, a body illuminated by diffused light will show these contrasts obliterated. This is the reason why, under such circumstances, full and round bodies appear flat, as can easily be observed by looking at an intricate building on a dull day. It is no wonder that photographs taken on such a day always have a flat appearance.

The portrait of a person would have an equally flat appearance if it received light from *all* sides of the atelier. This shows the necessity of employing a *one-sided* light when we wish to produce plastic pictures.

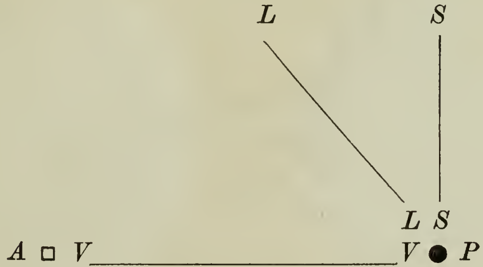
To make such pictures we supply our glass-houses with curtains, which we can raise or lower at pleasure. Such a *one-sided* light gives a living variation of light and shade. It does not follow, however, by any means, that the shaded side of a picture should not receive any light at all. On the contrary, it must be slightly illuminated, so that by chemical action too strong contrasts may be modified, that the details may become visible, and that there may be a gentle transition from light to shadow. In which direction then must the principal mass of light strike the person?

Different cases are possible. The light may strike the person from the front, *i. e.*, coming from the direction towards which the point of the nose is directed; or sideways, *i. e.*, horizontally at right angles to the previous direction; and finally from above, or in the direction of the longest axis of the body. We have to discriminate, therefore, between front-light, top-light, and side-light. Let us suppose now that the glazed side of the atelier is hung with curtains, and that a small slit is opened at the side of the person. If the person itself stands with its front at right angles to the glazed side, it is evident that it will be struck by the side-light. Turning now the chest and the head towards this light, it will be changed on the person to front-light. This shows that the direction of the light required depends on the position of the person, and it becomes necessary to define the expressions top-light, side-light, and front-light, in order not to be misunderstood; and as I shall in future frequently use these terms I will give the following explanation (see Fig. 97):

Suppose the paper be the floor of the atelier, and the square *A* the photographic apparatus, *P* the person. The direction of the head

and chest is a matter of indifference. We call the light which strikes the person in the direction of the line $V\ V$ (the connecting line with the apparatus) front-light; the light which is horizontal at right angles to this, in the direction of $S\ S$, we call side-light; the vertical light from above the top-light.

Fig. 97.



Besides these three principal directions the light can strike the person in other directions, for instance obliquely in the direction of the line $L\ L$, as front side-light, or obliquely from above, as front top-light, etc., expressions which are easily understood. It is now my object to describe the effect of these principal directions of light. I give four photographs, one of which, *T*, has been taken with top-light only, the other, *S*, with direct side-light, and the third, *F*, with front-light, the fourth, *T S F*, with a front top side-light. With the

T.

S.

aid of these pictures we will see what a powerful effect the direction of the light has on the *relief*, the color of the picture, the *resemblance of the features*, and the *whole character* of the physiognomy.

I consider it necessary to remark that the four pictures are portraits of the same individual, that they were taken immediately one

after the other, and excepting the light, under circumstances as nearly identical as possible. I make this remark because the surprising difference which these four pictures exhibit—only in consequence of the different illumination—has caused many who have seen them to express doubts that they really were pictures of the same person.

F.

T. S. F.

Now let us first consider the effect of the different lights on the relief of the face.

We notice in *T* that the eyes are deeply sunk in their sockets, the nose is projecting, and casts a long shadow; the forehead is white and glaring, whereas the chin appears dusky; there is no division from the neck, and the mouth is imperfect; the ears appear dark, because they are shaded by the hair; the coat and background show almost the same color.

In *S* the face appears as symmetrically parted in two halves, one light and one dark. The chin, which in *T*, nearly runs together with the neck as a gray flat mass, is shown quite distinct and vigorous in *S*, and shows a dimple above the upper lip. Two sharp wrinkles make their appearance, which are invisible in *T*. In like manner a wrinkle can be discerned aside of the nose. The dull eye in *T* assumes a pleasanter look in *S*. The coat stands out visibly from the background by its different colors, which is not the case in *T*.

F is like a box seen from the flat side; the sockets of the eyes are scarcely indicated. Of the characteristics which in *T* and *S* are to be seen, not a trace is left. The characteristic projecting chin in *T* and *S*, appears flat in *F;* the eyes are gray; the nose is gently lost in the eyebrows, and forms with these two symmetrical nooks. The whole is like a board on which the main outlines have been drawn. *This shows that with the aid of illumination we can obliterate wrinkles and cavities in the face, or can make them appear more prominent.*

When we consider the effect of the illumination on the color of the different parts, we will notice at once the great difference in the color of the hair. They appear gray in the photographs T and S, where the light falls on them (the most so in T), while in F the color is more black.

In T we recognize each individual hair, and also on the light side of S, while in F the hair forms a homogeneous black spot, with very little detail.

The cause of this want of detail is the equal illumination which every hair receives from the front, so that we can only see the light side. It is quite different with side-light, where we see on every hair its bright and its shaded side, and thus each hair becomes distinct from the other. The hair in F appears much darker. The reason of this is that the model was much further removed from the light when the picture was taken. This is also the reason why the coat appears much darker, and the background much lighter than in S and T, simply because it received as much light as the sitter (except where the background is shaded by the person), while in T and S the background stands a few feet back of the light opening, and receives only that part of the light which either vertically or horizontally strikes the person.

The bright color of the coat on the illuminated side in T (the coat of the sitter was black) must be noticed. *This demonstrates that with the aid of illumination we can modify to a considerable degree the color of hair, background, and clothing.*

The next point to be considered is the effect of illumination on the character of the picture; and the most superficial observer must admit that a great many, who believe that a clean and neatly executed picture must always be a good likeness, are grossly in error.

The eyes in T look dark and weeping, and this sinister expression is increased by the dark-colored mouth, and the dark cheek and chin. How harmless and even sleepy the picture in F appears. The shadeless eyes look fishlike and expressionless, the lines which give energy to the face are wanting, and the mouth is without expression.

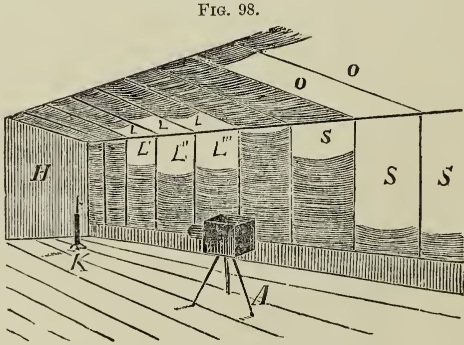
The picture S is intermediate between the two. It is not so insipid as F, nor so stern as T. The contrasts of light and shade give a lively expression to the face, only the shaded side appears still a little too threatening when compared with the light side. The picture is more characteristic than the other two, but it does not show us the man as he is; it is too angular, and he looks too much like a goat. *We see from the above how the whole character of a face may be varied considerably by illumination.* We can make a gruff and unhappy-

looking face appear to look cheerful and pleasant, and we can give an energetic expression to a sleepy-looking countenance.

But my readers will ask, Which of the three pictures shows the true character of the man? and I answer, None of them. That every one may get an idea how the man actually does look, and form an idea how the three different modes of illumination have changed the expression of his countenance, I add the portrait which his friends consider a perfect likeness, and a true representation of his character in *T S F.*

In this picture the shadows in the hollow of the eye are not as deep, however, as in *T*, nor as uneven as in *S*. Further, the wrinkles on the upper lip and near the nose, which in *F* are missing altogether. The shaded side is not as dark as in *S*. The whole face receives, through the gentle transition from light on the one side to the shaded on the other, a plastic effect, leaving the relief forms of the face stand out nicely without exaggeration (like the eyes, deep, in *T*, or the chin, high, in *S*). From the gentle play of light and shade arises such a gradation of tone as none of the other pictures show. This applies to clothing as well as to the hair and face. This happy effect of illumination is attained by a combination of the three different modes of illumination—*i. e.*, top-light, side-light, and front-light, or what is the same thing, a front top-light from an oblique direction. In this case the main quantity of light which strikes the person proceeds from an opening which is a few feet in front, above, and either to the right or left, in such a manner that the light strikes the sitter at an angle of about 45°. In an atelier which is hung with curtains as illustrated in Fig. 98, such an arrangement of the light is easily managed by re-

Fig. 98.



moving some of the top curtains, *L, L*, and the adjoining side curtains, *L'*, *L''*, a few feet in front of the person, *K*. These openings,

in clear weather, during the summer, would answer for an artistic illumination, and painters, in fact, make use of such. But in photography, the shadows so obtained are too dark, and would produce an effect like the picture *S*, therefore the whole space, and with it the shadows, must be lighted up by opening the side-light curtains, *S*, *S*, and the skylight curtains, *O*, *O*. If a quick exposure is desired, the curtains between *S* and *L*, and between *O* and *L*, are also drawn up. The shaded side can also be lit up by a reflecting screen.

The method of illumination abovementioned produces the rotundity and relief of the model in the richest manner, and painters make it the foundation of their shadow constructions.

We find this illumination also in most of the pictures of our prominent portrait painters, simply because it appears to our feelings as being the most natural, and there are many photographers who will, as if by instinct, place their model in exactly that corner of the atelier where this mode of illumination is produced by local causes. Others, again, have put up curtains and removed them again, have changed their glass-houses, until finally their pictures assumed that natural appearance which depends altogether on the illumination.

When we consider the effect of such a normal light on the model, we will find that on the forehead (for instance, on the right), is the strongest light, while on the opposite side, on the lower jaw, we will find the deepest shadows. There are a number of ateliers where this mode of illumination is employed with every model, without exception.

The model is placed in a spot from which the side and top-light is partially excluded by curtains and masonry; consequently he will receive light mainly from the side front. Curtains are thereby often unnecessary if the position of the atelier has been correct from the beginning. Otherwise, a few screens placed in proper position will assist.

Such an arrangement may suffice for a great many faces, but it cannot be denied that by employing the same mode of illumination invariably, the pictures will become monotonous.

In photographs this monotony is even more objectionable than in oil paintings, as the painter by the aid of colors has the means to produce a great variety of effects. It is quite different with the photographer. In his hands light and shade have to replace the effects of color. He can replace variety only by a skilful manipulation of the illumination, and the more or less inclined angle under which the light strikes the object is here of primary importance.

We have to mention that a top-light, *O*, or a side-light, *S* (Fig. 98), proceeding from a great distance, produces a similar effect to that of a front-light. A top-light of large dimensions, immediately above the sitter, is in its effects similar to a side-light, a circumstance which must be borne in mind in an atelier which is wide, but comparatively low, and *vice versa*. A very high side-light will produce similar effects to a top-light, as can easily be noticed in any very high atelier.

It follows that as we increase or diminish the size of the opening, *L*, *L*, or as we approach it or remove the sitter from it, we can give to the light more or less the character of front-light, top-light, or side-light, and modify the character of the model to a considerable extent.

Suppose we have a well-marked, energetic, and expressive face. By removing the sitter from the source of light, we give the character of front-light to it, and infuse mildness and softness into the harsh features.

And so the other way, when we have a flat, sleepy, and otherwise little-marked face, we should give to the light more of the character of top-light, and the face will get more energy and life.

With certain small-cheeked faces, the employment of side-light is to be recommended. It lights up the cavities under the cheek-bones on the light side, makes these concave parts appear more rounded and full, while the details on the other side are lost in shadow.

For ladies of a "certain age," who sometimes become very annoying to the photographer, the employment of a gentle front-light is to be recommended. It will light up the wrinkles and remove the unpleasant shadows.

Yes, we can place the whole face in the shadow (which of course must not be too dark), only throwing a few light-effects over the most prominent parts, and still get good effects.

Generally speaking, we may lay down the rule that we must illuminate all the elevations and depressions which we wish to modify, in such a manner that they throw no shadow, or only a very small one, and *vice versa*.

By such tricks in illumination, not only the parts we intend to remove generally suffer, but also the neighboring ones which ought to remain. Flatness easily steps in, and therefore it is now preferred to modify deep shadows and wrinkles by retouching the negative. The most judicious and artistic illumination is that of the picture *T S F*, and with this a majority of cases can be reached. A turning of the head more to the light, or shaded side, placing the figure for-

wards or backwards, will produce those variations easily, which are stipulated by peculiarity of the physiognomy. Important here is the application of the tricks in illumination.

We can modify the shortcomings of the original, but we must not obliterate them altogether, for in that case character and likeness would be lost. How far we may go in this respect cannot be determined by any rule, but the thinking artist must be guided by his sight and the gift of observation.

The observing artist will also notice a slight difference in the brightness of the hands and the face. *In every portrait the face is of paramount importance. It must receive the principal light, and all the other parts must be kept subdued and subservient to it.*

Nothing can be more repulsive than those pictures where the arms and hands appear as prominent white spots, strongly contrasting with the drapery and clothing. The upper part of the body should be kept lighter than the lower parts. *With dark screens, which are placed a few feet from the sitter, and partially shade the hands and feet,* this is easily accomplished. Loescher & Petsch use such a shade-screen with great advantage, particularly in avoiding over-exposure of white dresses. The screen is a frame five feet wide, covered with dark cloth, and moves on rollers. The upper part is movable around a horizontal axis, so as to give more or less inclination. It is self-evident that the production of such light-effects requires a skilled eye, which will appreciate the slightest gradations from light to dark.

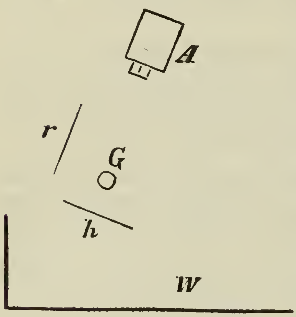
For training the eye in this respect, I would recommend the photographer to practice on plaster of Paris busts. Such busts should be placed in the atelier on the same spot where the sitters are placed. All the light should be excluded by closing all the curtains, and now, by admitting the light first from one direction, then from another, now from above, and next sideways, the effect on the face should be carefully watched.

The variations are not only surprising, but entertaining and instructive, and whoever will take the trouble to photograph them, and make a short memorandum of the mode of illumination, can make for himself an album of studies that will materially assist him in selecting the proper mode of illumination for the living model. More important are studies from living models.

Here must be observed the peculiar light effects, which occur when the person moves away in the curtained position, Fig. 98, from *K*, towards the camera; the light then comes in from the back sideways, and this paired with the front-light, coming from *S* and *O*, produces

a very fine effect. This brings us to the so-called Rembrandt effect, in which the whole face is dipped in a half-shadow on the side, while generally on the profile a sharp edge of light is shown. These effects are produced by the annexed arrangement, Fig. 99. *W* is the open side-light, *G* the person, *A* the camera, *h* the background, *r* a very light reflector. Moreover, a slight degree here is only brought into use. The person inclines the face towards the right (in the figure), so that it appears in profile at *A*. The objective must be protected with a screen from the direct light of the side-light. In such Rembrandt effects there was and is yet much accomplished, or sinned. The pictures look very effective, but, as the illumination is an unusual one, the persons appear also unusual, and therefore unlike. Whoever has an eye for light effects can produce more such tricks, which we however would rather recommend for artists' pictures (actors) than for the great public. Kurtz's arrangements for taking Rembrandts are shown herein further on. In Berlin the taste for such pieces of light effect has died away rapidly. They might still draw at other places. One thing must not be forgotten, *i. e.*, " One rule will not apply for all," and care should be taken not to use one and the same light effect for all persons, regardless of sex, age, or peculiarities of the physiognomy.

Fig. 99.



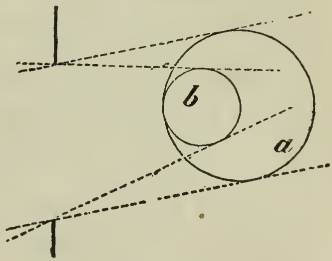
All that I have shown as taking place on the human face repeats itself on all other forms. Just as cavities or prominences on the human head can be obliterated or exaggerated by the mode of illumination, so also can we modify the appearance of other plastic objects, as buildings, bas-reliefs, machinery, etc.

It is the rule to illuminate in such a way that the details which we desire to show prominently in the picture are by the illumination brought to the proper prominence. Art objects make the choice of illumination easy, in so far as all artists place their models under a light which strikes the object at an angle of 45° obliquely from above. Whether the obliquity is from the right or the left side is still a question, and when the artist himself does not give the direction, experiment must show from which side the light acts the most favorably. Without subjecting oneself to examination and criticism, we will never obtain a satisfactory result.

This oblique light with an inclination of 45 degrees will, under most circumstances, be the most suitable.

Two more points have to be considered,—the size of the object and the distance of the source of light, *i. e.*, the window of the atelier. Suppose we have two pillars, one of large diameter, *a* (Fig. 100), and a small one, *b*, placed at equal distance from a window. It will be easily seen that the first will show a different illumination from the second. The light plays more around the smaller pillar on the shady side than on the large one. The shady side contracts while the light side expands. If we wish to photograph the smaller pillar, under similar conditions of light and shade, we have to decrease the light *opening*. This is the reason why an illumination which has been arranged for a life-size model is unsuited for a smaller object.

Fig. 100.



The second point is the distance from the glass wall.

We have shown above that the brilliancy of a point, which receives the light of the sky through a window, decreases as the square of the distance from the window increases. With a very large window opening this decrease is not so strong, but still very perceptible when we consider that in such cases the shady side of a model is only illuminated by the light reflected from the back wall of the atelier. It becomes evident that the contrast between light and shade will be stronger as we approach the model to the glass wall; we have it in our power, therefore, to increase or decrease these contrasts by placing the model in different positions.

It must not be overlooked that, generally speaking, contrasts are stronger in photographic pictures than they appear to our eyes. Very often the shaded side, which to our eye represents all the details, appears on the photograph as a pitch-black spot. This is most striking with yellow, green or red objects, less so with white ones, or cobalt and ultramarine blue.

A plaster bust will generally, even without artificial arrangements, show good details in the shadows, but it is different with human beings, and still worse with dark-colored objects, such as iron and bronze. When it is intended that the shadows of such objects shall not appear altogether black, we must either introduce direct light on the shadow side or arrange reflectors to throw the light in that direction.

In an atelier with a north front the illumination of the shadows by direct light is an easy matter. Generally the model is handled as we have already described.

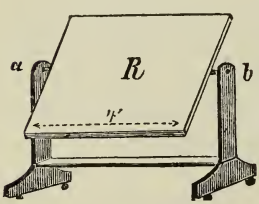
To the eye the effect is visible on the model. By increasing the amount of front-light the time of exposure becomes relatively shortened. The light and shade contrasts become more and more decided by approaching the model to the glass side of the house.

The illumination by reflecting screens is very generally employed. When the atelier is small and the rear wall light, the latter will act as a reflector (see effect of indirect light), and many photographers will only notice this fact when they are suddenly placed in another larger atelier with a dark rear wall. The floor of the atelier acts similarly to a reflector. It lights the lower shadows of the model. This effect is also very often overlooked. Every object in the atelier, provided it is not absolutely black, acts more or less as a reflecting screen. Those photographers who boast that they work without reflecting screens may make a note of this.

We have taken pictures in which a lady sat reading at a table, the head inclined over the book. Here the whole face was in the shade, and this was only lit up by the book itself acting as a reflector. Of course this must be placed so that the reflected effects can be really seen. For what cannot be seen with the naked eye generally does not appear in the picture. Just as advantageously we use the white dress of a standing lady as a reflector for the shadow side of her sitting neighbor in a group. Such means dare only be applied without being noticed in the picture. A hidden looking-glass often is very serviceable.

For a movable reflecting screen I would recommend a frame, *R* (Fig. 101), which revolves around the horizontal axis, *a b*, and is moved from place to place on rollers. Others are so arranged that they can be placed high or low. One side of the frame should be covered with tin-foil, the other with white paper. This secures two surfaces of different reflecting power.

FIG. 101.



The frame is placed on the dark side of the model, and moved in different directions until the eye observes that the shadows become lighter.

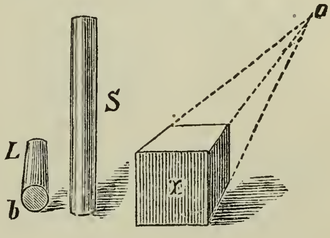
To the beginner I would recommend experiments with a plaster bust. The effectiveness of the screen increases the nearer we place it to the model (see effect of direct light). As regards the most suit-

able position of the reflecting surface we soon notice that; even with a dull surface, such as paper, the action is analogous to a mirror, *i. e.*, the angle of incidence is like the angle of reflection.

OF THE PERSPECTIVE.

When we look at a cube (Fig. 102), the sides of which being of equal length, we will find that they *appear* to our eye of very different length. The surface fronting our eye appears as a square; the others become shortened in a remarkable manner. The surfaces appear quite irregular; the parallel lines converge towards the point *o*. Similar appearances we notice on all other bodies. The human arm hanging down along the side of the body, or the pillar, *S*, standing upright, appear of *full* length, while the arm stretched towards us, or a pillar lying in a horizontal position, *L*, appear "foreshortened." The parts appear contracted, and finally we see, instead of the shaft of the pillar, only the circular base, *b*, which either appears circular when we face it directly, or as an ellipse (which it is not in fact), and the parallel sides of the pillar converge to a point. The reason why we do not notice this falsehood (for such it is) is simply because we are used to it.

FIG. 102.

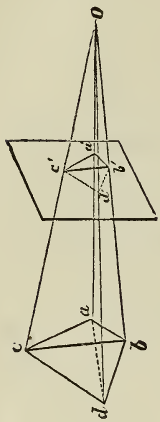


We know from experience that the arm pointing towards us only *appears* short, and that it is longer than it appears to us. We know also that the apparently converging railroad tracks run actually parallel. We constantly correct, by our experience, the appearances of our vision. A child without experience will try to seize the moon. It is the duty of the painter and the photographer to represent the foreshortening correctly, *i. e.*, as they *appear* to our eyes; and when this is not done the picture will be untrue.

The perspective teaches us the laws of foreshortening. Our eye is a camera obscura with a simple landscape lens. We know from optics that the image of a point lies on the straight ray which is drawn from the point through the centre of the objective. Where this line, which is called the principal ray, cuts the plane of the picture (the ground-glass in the camera or the retina in the eye), we will find the picture of the point in question. The image of a straight line is

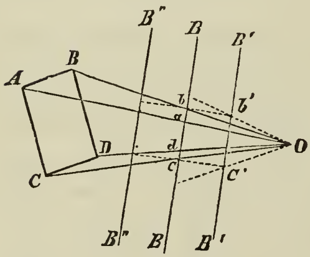
where the rays which proceed from the different points of the line, after passing through the centre of the lens, intersect the ground-glass. These lines form a plane in the optical centre. This plane cuts the plane of the ground-glass in a straight line. The image of a straight line is, therefore, in our eye a straight line, and the image of a plane triangle is a plane triangle. When the plane figure on the retina, or the ground-glass, is parallel to the object, then, according to well-known stereometrical laws, the image will appear similar to the original figure. Suppose that a plate of glass has been placed in front of the eye vertical to its axis. Then the rays which proceed from an object, *a b c d*, will intersect the plate in the figure *a′ b′ c′ d′* (Fig. 103). When we construct such a figure for a given point of intersection and a given plane, then the drawing, when it is brought to the correct position and distance in front of the eye, will give exactly such an image as the objects themselves. This explains the deception that a correctly constructed plane picture appears in relief. A picture drawn in the above-described manner we call a perspective drawing. It is self-evident that we must look at it under the same conditions under which it was drawn.

FIG. 103.



Suppose that *A B C D*, Fig. 104, is the ground plan of a house, *B* the ground-glass, *O* the focus of the rays, *a b c d* the image of *A B C D*; then it is necessary that I should place my eye at *O* in order to see the perspective picture, *a b c d*, exactly as the object itself.

FIG. 104.



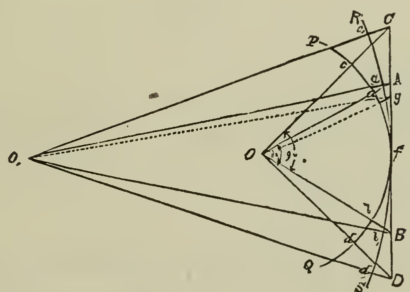
When I move the ground-glass closer to the eye, for instance to *B′*, it is easy to see that the rays must cross each other in the eye under an entirely different angle from those which proceed from *A B C D*; and they cannot produce a correct impression. The same would take place if I should remove the picture-plate away from the eye (for instance to *B″*). Hence it follows that every perspective drawing should be looked at from the standpoint from which it was taken in order to produce a correct impression.

A photograph is a perspective drawing where the point of sight lies in the object-lens; and hence the eye must be placed at the same dis-

tance as the object-glass (*i. e.*, its focus). When this is not done the impression is untrue.

There are, however, lenses of four inches focus and less; at so short a distance it is impossible for the naked eye to see a drawing, or anything else. Generally we look at them at a distance of at least eight inches, and the consequence is that the photograph produces an un-

FIG. 105.



natural impression. This is very often the case with pictures taken with wide-angle lenses.

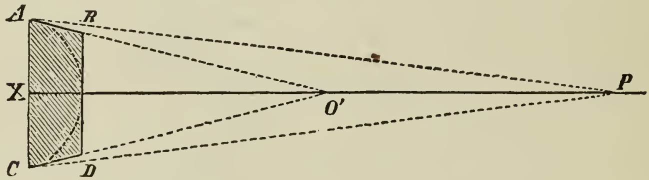
When we look at these from too great a distance, $O' f$ (Fig. 105), we will notice the too great expansion of the marginal parts. The foreground and the sides appear disproportionately large. When they are placed at the correct distance, $O f$, which is equal to the focus of the lens, then the angle of vision, $C A O$, of the too wide marginal parts, $A C$, $B D$, will shrink considerably, as they will be seen considerably foreshortened (see above), and the picture will make a correct impression.

These errors do not show themselves in so striking a manner with pictures that have been taken with lenses of a smaller field of vision. When, for instance, the angle is equal to 60°, it does not make much difference whether we look at the picture from the single or double focal length, as a glance at the small marginal piece, $A g$, of a field of vision of 60°, will demonstrate. This is the reason why we do not notice the false perspective, so common in portraits which have been taken with lenses of a short focus, as the field of vision of these lenses is less than 60°. But other abnormities will manifest themselves which we must not overlook.

When we take from the point P (Fig. 106), the picture of a pillar, the ground section of which is, $A B C D$, the lens to have a focus of seven inches, we obtain a picture in which the sides $A B$ and $C D$ are visible. When we substitute, however, a lens of three and a half

inches focus we would have to approach the object in order to obtain a picture of the same size as with the seven-inch lens. For instance, from the point O', the sides $A\ B$ and $C\ D$ are no longer visible; the whole character of the picture becomes changed. When we substitute a human face for the pillar it is evident that, with the lens near to the object, the cheeks will contract and appear too narrow in proportion to the length of the face.

Fig. 106.



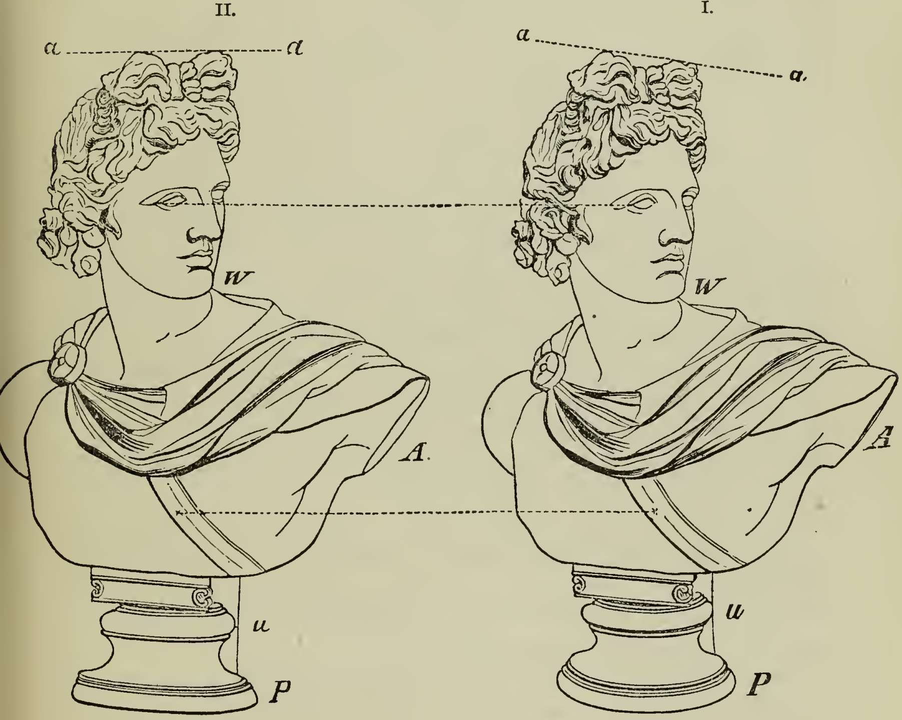
The correctness of this conclusion the following two illustrations will demonstrate (Fig. 107). They represent two pictures of the bust of Apollo. The bust was placed exactly vertical, the camera likewise, and the direction of the line of vision carefully adjusted. The picture, No. I, was taken with a small patent Dallmeyer lens, at a distance of 47 inches; the picture, No. II, was taken with a Steinheil Aplanatic lens, at a distance of 112 inches.

The difference is striking. In No. I the figure appears slender, the chest is almost feeble, while the same model yields in No. II a full-faced, robust figure. That this slenderness does not depend on an illusion a measurement of distances will best illustrate. The distances between the eye and the point marked on the chest with a cross are exactly alike. The greatest expansion of the chest, however, including the stumps of the arms, amounts in No. I to 56 millimetres, and in No. II to 59 millimetres. Looking aside from this dissimilarity, the character of the two faces will reveal to the attentive observer other striking differences. A line, *a*, *a*, applied to the hair of the figure will run horizontal in No. II, while in No. I it inclines to the left of the figure. The pedestal, *P*, differs likewise. In I, the rings are strongly inclined ellipses, while in II they are quite flat. The stump of the arm, *A*, *A*, shows hardly any surface in I, while in II it becomes quite prominent. The support of the back extends in No. II, at *u*, further to the right. The head is in II more between the shoulders (see the angle of the neck at *W*), and the whole figure seems to elevate the head more in No. I than in No. II. In II the head seems almost to incline forward, and yet the figure was immova-

ble, the lenses were free from distortion, the direction and height was in both identical; nothing was different but the distance.

Besides the two pictures above described, two others were made under exactly similar circumstances at a distance of sixty and eighty inches, and when we place the four heads alongside of each other, we notice that with increasing distance the figures appear stouter and more

Fig. 107.



robust, the head line inclines more and more, the ellipses of the pedestal become flatter, the chest increases in breadth, and the stumps of the arms become more prominent. These differences will show themselves when we take the same head with the *same lens* and only change the distance from the object.

The author took the Apollo head with a Dallmeyer stereoscope lens at distances of five and ten feet. The latter picture is of course only half the size of the former. Differences were not visible to the naked eye on account of the smallness of the pictures, but they became quite evident by magnifying them, and showed the same differences as shown above in the illustrations.

We thus see how *different distances yield different pictures* of the same object, exactly as a different direction of the light will give a different character to a portrait of the same person.

Some will say that all this is trifling, and that it does not make much difference whether the Apollo is a little stouter or a little more slender. So far as the Apollo is concerned this may be a matter of indifference (most people do not know how the Apollo looks at all); but the case is quite different in portrait photography, and where the customer's own dear self is concerned. For their own physiognomy even inartistic people have an exceedingly keen eye. The most trifling things—a line, a wrinkle, a curl—is criticized, and differences, which are not noticed in the Apollo, are easily observed in the counterfeit presentment of themselves.

It is the duty of the photographer to pay attention to distance.

To the photographer who only works mechanically this may be an inconvenience; but the intelligent and ambitious artist will know how to take advantage of it. He will not make a thin person appear still thinner by taking a photograph at a short distance, nor will he increase the circumference of a stout one by placing a considerable distance between the camera and the model. This is particularly the case with bust pictures, but still more so with large heads, where on the one hand the distances are short, and where on the other hand the breadth of the body is almost equal to the height of the figure (so far as the same is visible in the picture).

With standing figures, where the breadth is comparatively small in proportion to the length, these errors caused by distance are not so apparent.

Perhaps many will wish to know which distance is the proper one, and which gives the most correct picture.

This depends upon the individual, I might say, and refer to the example of the stout and slender person, which I gave above, and where entirely different distances are proper. Generally speaking, painters recommend, for making a drawing, a distance which is at least twice as great as the height of the object. For a person five feet high, the distance would be ten feet; for a bust (half the length of the body), a distance of about five feet.

The painter, however, has greater freedom. He can add, or leave off, or change, just as he chooses. His guide is his artistic feeling. I think that the photographer needs this feeling also. The opticians have furnished him with different lenses, that he may make pictures of the same object and of the same size from different distances. A

portrait photographer should be provided with lenses of different focal length.*

Everything is proper *when employed in the right place.* And thus the question is answered: Which portrait apparatus furnishes the most correct picture, particularly when the negative has to serve for enlargement?

The preceding chapter will demonstrate that even a correct drawing lens will give different pictures at different distances. I obtain a different result when I take a picture at five or ten feet distance. With small-sized pictures, these differences are not very striking; but when we enlarge to life size, they become very noticeable, and every one will observe them.

Let us suppose that the original is five feet high, then it will require, according to the above academical rule, a distance of ten feet to give a proper standpoint for the contemplation of the same. But in order that the picture should make a correct impression at this distance, it is necessary that the negative be taken at the same distance, no matter with what objective, provided it draws correctly and defines sharply. If it has been taken at a shorter distance, the life-size picture will appear, under the given propositions, untrue.

These circumstances are modified by the nature of the object.

Let us take as an object an artistically sculptured chalice. In drinking out of it or in looking at it we take it in our hands and place it at a distance of about two feet from our eyes. We will get a true picture of such an object only by making a photograph at such a short distance, and the truth of this assertion becomes quite evident when we magnify a picture which has been taken at a greater distance. The untruth of the latter becomes evident at once by comparing the picture with the original, particularly when the width of the latter is large in comparison to its height.

Cavities are different from prominences.

When $A\ B$, $C\ D$ (Fig. 108), is the interior of a box, we will see the side $A\ B$ from P much more foreshortened than from O' or N. If, therefore, a picture is taken under like circumstances from near or far, it will appear in the former case broader in proportion to the

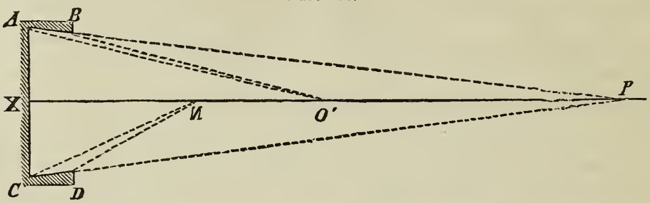
* For large heads of carte de visite size, which are now in so much demand, he should have three numbers of sufficient light (a point of great importance) at his command:

1	portrait	head of about	24	lines and	4	inches focus	at about	5	feet distance.
1	"	"	30	"	7	"	"	7	"
1	"	"	36	"	12	"	"	11	"

In most cases the second one will be sufficient.

height. This relation becomes evident in taking a perspective street view. At a short distance, with a wide-angled instrument, the nearer

Fig. 108.



parts will appear unusually broad. The same will happen when we suppose that *A C* represents the body and *C D* the lap or the feet of a sitting person. The lap will appear much broader in proportion to the body. It would be the same if *C D* represented the feet of a person facing the camera. They would appear larger from *N*. Finally, let us imagine that *C D* represents the carpet or the floor of a room; it would appear broader or with a steeper ascent from *N*. When we take a picture of one and the same person from two different standpoints, *P* and *N*, with two lenses of different focal lengths, in such a manner that the height of the body shall remain the same in both pictures, we will find in the pictures taken at a short distance that the projecting parts (hands, feet, lap, etc.) are too wide, while the receding ones, as the cheeks, are too small; the floor and chair ascend too much (Fig. 109). For comparison, look at the picture, Fig. 110, which has been taken from a greater distance. When we

Fig. 109.

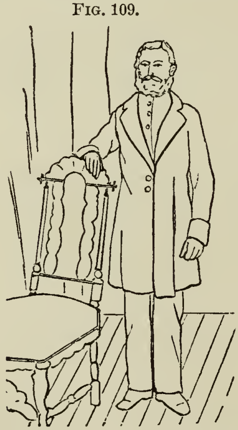
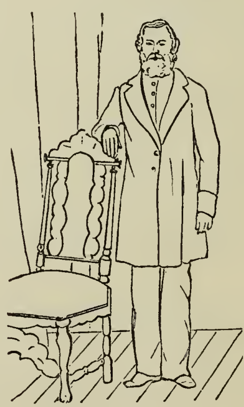
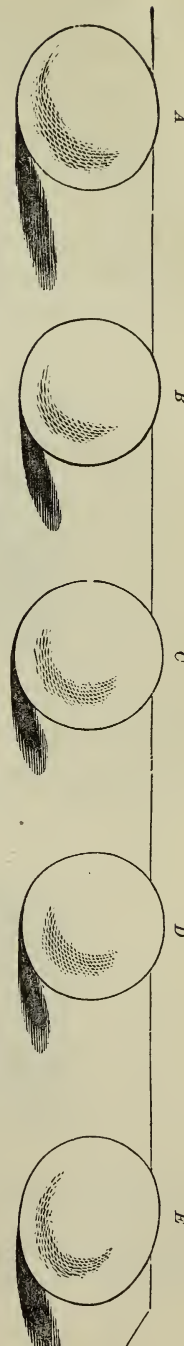


Fig. 110.



suppose that *A B* (Fig. 108) is the ground-plan of a house or a window, then it will appear broader when taken from *O'* than if taken from *P*.

Fig. 111.



This is the reason why windows and doors appear too broad when taken at a short distance with a lens of a wide field of view, and hence look compressed, as will be noticed in many pictures taken with a pantoscope apparatus. This is also the reason why the distance of the apparatus and the size of the field of vision are of so much importance in giving a true picture of an object. How, under these circumstances, and even with a perfectly correct perspective, quite abnormal figures are produced, the annexed picture of balls will demonstrate. Balls will always appear round to us, or circular; but when they are located at the margin of the field of vision—*i. e.*, when the rays intersect the plane of the picture under a very oblique angle, then the perspective figure, even when mathematically correct, will be an ellipse.

Such a figure we will not consider a true one, as our eye has been accustomed to seeing a ball under any circumstances as a circle, and we cannot blame the painter when he ignores the rules of perspective and draws them always as circles. Unfortunately the photographer cannot do the same; he must reproduce the figure which the lens, constructed according to mathematical principles, furnishes.

Distortions similar to those described on the balls will always manifest themselves with lenses of comparatively small fields of vision. The balls *B* and *D* are on the margin of a field of only about 35°. The balls *A* and *E* are at the edge of a field of $64\frac{1}{2}$°. The former angle is nothing unusual with portraits, particularly with groups. The latter is frequently employed in landscape and architectural photography. The marginal figures will easily appear too thick when taken at a short distance with a wide field of view. Look at the two figures (Fig. 116, Fig. 117); they are the marginal figures of the same bas-relief; the one taken at a distance of $3\frac{3}{4}$ feet, the other at $8\frac{3}{4}$ feet. The head in Fig. 117 appears twisted, thick, and the left foot turned outwards, while Fig. 116 is more correct.

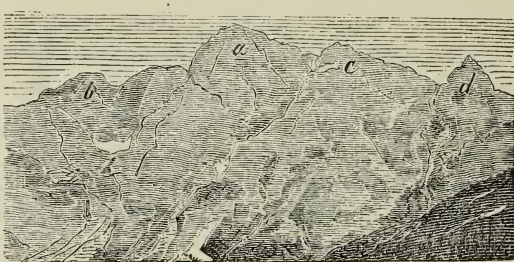
In taking groups a long distance should be chosen, and stout persons should not be placed at

the margin, but in the centre, and we should only employ a large field of vision when circumstances admit of no other.

That a too large field of view in landscape photography produces a too broad foreground, has already been mentioned (see above).

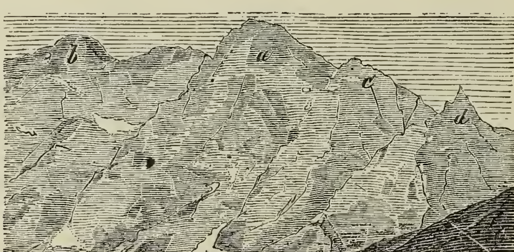
This is apt to disturb, especially when the main object of the picture lies in the distance, which appears aside of the large foreground small and cramped. The large field of view leads also to singular changes of shape in the figure of a landscape. As proof we annex two pictures of the same mountain view of the Carpathian Range, which we made with a pantoscope and a Steinheil. Fig. 113 represents the right side of the Steinheil; Fig. 112 the right side of the

FIG. 112.



pantoscope picture. The total difference of the mountain outline appears to the eye at once. A superficial resemblance is here; this concerns only the grouping of the mountains and their general form. In both figures, *a* is the highest mountain; *b* is, however, in Fig. 113,

FIG. 113.

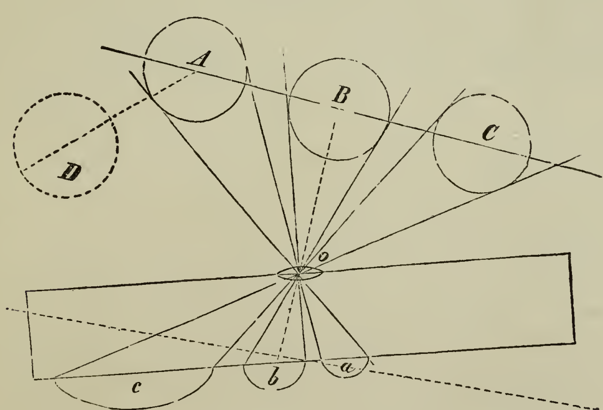


the second highest, in Fig. 112 the lowest of all. The pointed mountain at the right appears broader in Fig. 112 than in Fig. 113. If both pictures are now carefully compared with nature, it will be found that the Steinheil comes nearest to it; it gives the outline of the

mountains more correctly. The pantoscope, however, makes a better total impression, which is not in the optical, but clearly to the landscaping relations. Such deviations are shown much oftener than is thought; they have been so far overlooked. That they occur lies simply in the nature of the perspective, according to which our instruments delineate, and in this will be found its solution. A similar distortion occurs here as with the five balls (Fig. 114). What is said of a sphere will also apply to a hemisphere. Imagine in front of the camera a row of hemispherical-formed mountain-tops; these will suffer the same distortion, on the edge of the field of view, as the balls; they will be broader. If the balls are not in a row, but in a semicircle, *i. e.*, the balls on the side nearer to the camera than the middle ones, the broadening will be worse. Something similar occurs in nature, when, for instance, the mountains form a mountain hollow, it will appear the more striking the larger the field of view. The one picture (Fig. 113), is cut out of the side of a plate, the field of view being 60°. The point of sight was under the highest summit. This summit was nearest to the edge, and suffered therefore the distortion; it extends still higher. This extension is explained by imagining the five balls in a perpendicular position (Fig. 114).

The other picture is from a plate, with a field of view of 90°; the point of sight was towards the left below the second highest mountain

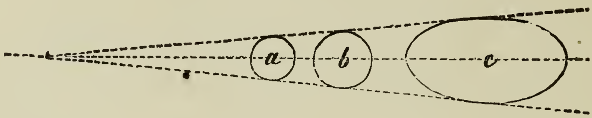
Fig. 114.



b (Fig. 112), therefore the parts lying to the right in the former moved, in the latter, more to the edge; they were analogous to the balls *A* and *C* on account of the broadening caused by the large angle of vision, and more striking than in the first picture, in which it

was scarcely possible. Now the heightening of single mountains is yet to be explained. Three balls placed in a row, the camera in this case imagined very broad placed parallel in front of them, produces a picture which of course shows a broadening of the balls at the edges, but no degree of heightening. All pictures have in a per-

FIG. 115.



pendicular position the same diameter, as shown in Fig. 111. If, however, the balls lie oblique to the camera, as in the annexed cut, Fig. 115, the picture will be different. The three balls, which in the first parallel position of the camera appeared of the same height, but different breadths, appear now, not only of different breadths, but also different heights, *i. e.*, the ball at the edge *c* higher than *b*, and this higher than *a* (Fig. 115). For this reason the mountains grow in height and breadth, on the edge of a landscape if the camera is placed in a similar position; thus, this singular fact finds its solution in the simple laws of perspective.

The artist who paints a landscape cannot, according to this, strictly conform to the laws of central perspective; he corrects the construction which the perspective produces with the impression made on his eye by nature. The question now is, if such failures can be photographically avoided. The answer is, yes, but only partly, *i. e.*, by the aid of a camera having a ground-glass which can be placed in an oblique position. We mean, however, such a one which moves on a perpendicular axis. Imagine the ground-glass, Fig. 114, without changing the position of the camera, turned so as to be more parallel to the balls; for instance, in the position of the dotted line, the failure for the right-hand side will be less marked. For the other side it is of course reversed; here the distortion by the turning of the ground-glass will be worse, because the ground-glass is placed in a more oblique position to the (dotted) ball on the left. Very often, however, the characteristic objects of a landscape are on one side of the picture, the other side being of an inferior nature; a little distortion in this case is of little consequence. The inclination of the ground-glass can be done to correct the other side very advantageously.

Still another point is the height of the apparatus and its direction.

The normal position of the apparatus is the horizontal one. In that position the eye-point—*i. e.*, the point where the continuation of

the axis of vision would intersect the plane of the picture—would fall in a line exactly in the horizon—*i. e.*, in the line where, on a large sheet of water, the water and the sky appear to meet.

Fig. 116.

Fig. 117.

This normal position, however, is maintained by photographers only in taking architectural views. When it is neglected, in such cases the vertical lines of the buildings will not appear vertical, but inclined—*i. e.*, converging at the top when the apparatus is turned upwards, and converging at the bottom when the apparatus is turned downwards.*

Such pictures look very ugly. With portraits and simple landscapes we very often deviate from this horizontal position. The eye-point must be looked for either in the ground or in the sky. In this case we will see in the former instance more of the ground, and in the latter more of the sky. Under some circumstances this may be an advantage. In rows of trees, where we wish to avoid an excessive foreground in order to get an insight into the splendid mass of foliage, we must direct the apparatus upwards.

* The explanation is easy. The rays proceeding from a straight line will form a plane at the point of crossing, and this will intersect the plane of the ground-glass in a straight line. When we imagine a succession of lines parallel to the ground-glass, the planes of rays proceeding from them will intersect the ground-glass in parallel lines according to well-known geometrical laws. When, however, the ground-glass is inclined, the intersecting lines will converge.

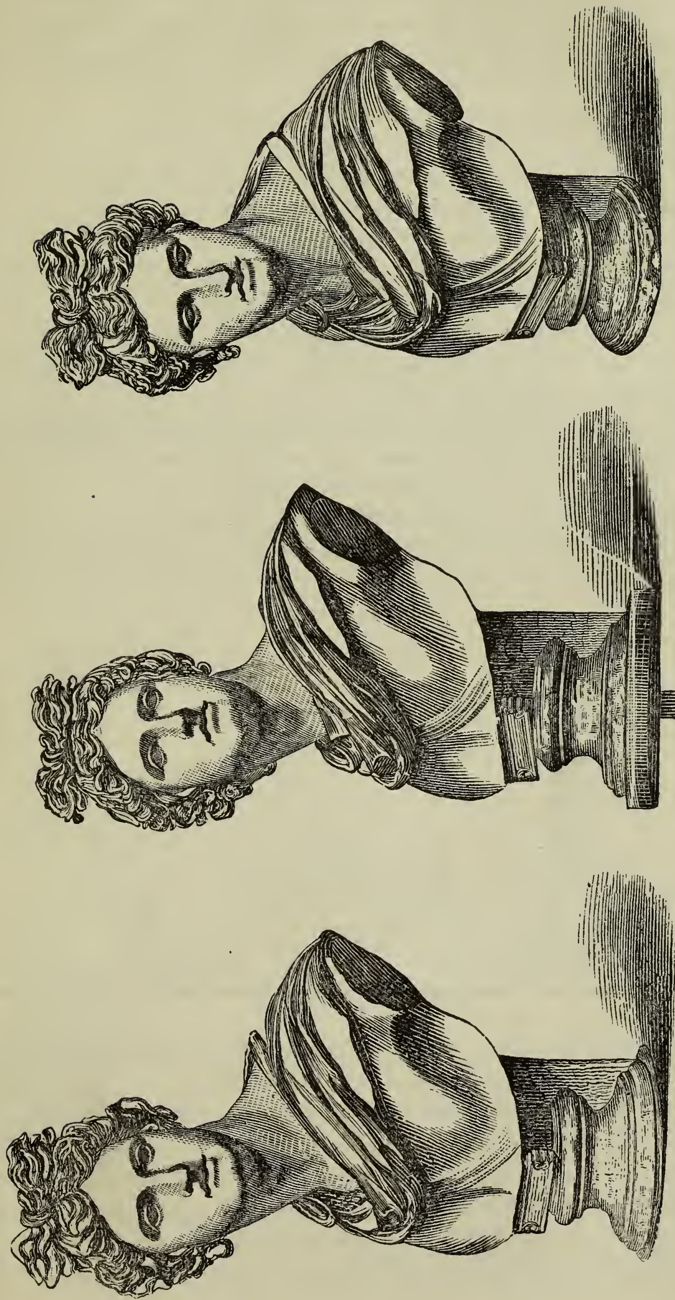
Bedford has done this. That the stems of the trees converged did not matter much. What influence the inclination of the apparatus exerts in portrait photography is shown most strikingly by taking the picture of a bust with an apparatus pointing upwards, and then from the same standpoint with the camera pointing downwards, as the annexed figure (118) shows. In the third figure the head appears to incline forward, like that of an old man; in the first the person stands perpendicular, like a soldier; while in the second instance the head is thrown backwards and the eyes are turned heavenward.

In this, one thing must also be borne in mind; the head is like a ball. If it is in the centre of the field of view it will be normal as the middle ball (p. 321); if above or below it is extended in its position of length, the same as the upper and lowest of the five balls if placed in a perpendicular position. A face can, therefore, be made slimmer by moving it out of the centre of the field of view; a quick eye can detect this already on the ground-glass. Focus a short-focussed lens horizontally on a head, so that it will be in the centre of the ground-glass. Then tilt it forward, so that the head is a little above the centre, it will be seen instantly that it becomes slimmer. In standing figures the head cannot be kept in the centre very well if the picture shall be sharp from head to foot. The objective should not be placed lower than the breast. The lens will see the head from below; the aspect secured can readily be seen in Fig. II in the Apollo, which was taken with a camera pointing up. It shows more of the chin, the nostrils can be looked into, the hair is shortened. To obviate this in standing pictures, let the person (by standing the apparatus low) incline the head slightly. In like manner, the failure shown in Fig. III, which occurs when the apparatus is placed high, can be avoided by placing the face of the subject a little higher.

The effect becomes still more striking with antique statues. Generally they are calculated and executed for a high standpoint. They must be copied with a camera turned upwards, while with reclining figures (Endymion, Cleopatra, or Queen Louisa) the apparatus should be turned downwards.

The elevation of the apparatus above ground is of still more importance. Many mistakes are made in this respect. The normal height is the height of the eyes above ground, which for a standing figure is about four and three-quarters feet. When the apparatus is placed higher, we will see the objects from above (bird's eye view); when we go lower, we will see the objects in what is called a frog perspective. For a sitting figure, we may assume the observer to be in a sitting posture—*i. e.*, the eye or the camera at a height of about four

Fig. 118.



III. Apparatus inclined forward.

II. Apparatus inclined backward.

I. With horizontal apparatus.

feet. For a sitting person the apparatus is generally placed on a level with the head of the model and inclined forward, while for a standing person the height of the chest and the horizontal position is adopted. In the former case we can elevate the head of the model; in the second case we can depress it to equalize errors.

When the apparatus is placed too high the person will appear more in a bird's eye perspective, and we see a larger part of the top of the head. The eyes appear depressed, the throat is covered by the chin, etc. When the apparatus is placed too low the reverse takes place. We look into the nostrils and the sockets of the eyes; we look under the chin, and the forehead becomes foreshortened.

In landscape photography the height of the apparatus is still more important. In order to gain a proper standpoint we have to ascend buildings and climb mountains.

We must observe that all the parallel horizontal lines which are not parallel to the ground-glass will converge towards a point in the horizon—the point of *disappearance* or vanishing-point.

As the horizon is located in the height of the eye—*i. e.*, the camera—it follows that the ground will ascend more and more as we raise

Fig. 119.

the horizon. See Fig. 120, where the eye-point is taken at the normal height of a human figure, the next at the height of the hips (Fig. 119), and the third at twice the height of a human figure (Fig. 121). In the first picture, where the horizon is lowest, the lines of the street ascend gently; the upper parts of the window, however, form strongly inclined, or, as they are called, *tumbling* lines; the lines of the step incline, and the milestone reaches to the clouds. When we ascend the steps (Fig. 119), the ground lines ascend more, and the window

lines are more horizontal. From such a standpoint the lower objects appear in a bird's-eye perspective; persons and trees become foreshortened and appear small and compressed; it does not create a natural

FIG. 120.

impression to see the ground ascend over objects which we are used to seeing prominently above ground, or to see the lines of window sills, which generally run in a descending direction, become ascending.

FIG. 121.

Such a high standpoint in taking a street view is only to be recommended when it offers other great advantages.

Here is still another point. In a perspective view, the lines of the

cornices of a building will appear to *tumble* when viewed from a normal standpoint—*i. e.*, the height of the eye of a standing person; more and more so the higher the building is. We are accustomed to calculate the height of a building from the degree of inclination of the upper lines. This is the reason why buildings taken from a high standpoint, where these lines approach to the horizontal, appear low and depressed, and fail to make a great impression.

Paul Veronese, who painted a splendid hall, knew this effect very well. He gave to the upper lines a strong inclination, and placed the eye-point intentionally lower for them than for the floor, in order to make them steeper.

He has offended the learned mathematicians, but gained in artistic effect. It is not intended that a picture should solve a mathematical problem or conform to it.

In narrow streets the selection of the proper standpoint is often so difficult that in spite of all our good intentions we must be satisfied with something very imperfect.*

ARRANGEMENT.

We very often hear in ordinary life the commonplace remark, "artistic confusion," and many draw the conclusion that every chaotic mixture of objects must be artistic. We will not investigate here how many photographers hold this view. I have known one who in order to heighten the effect of his landscape dragged all possible things into it. Piles of wood were carted to the place, stones were thrown in the foreground, the wheelbarrow on which the apparatus had been moved had to do duty, and when nothing else was to be had, the ground in front was dug up in order to make the view "*picturesque.*" He did still worse with his portraits; clocks, picture frames, vases, chairs, bottles, and footstools were so piled together, that finally it became difficult to find the person amongst the heap of rubbish.

It requires an advanced artistic education to understand that disorder and picturesque are ideas by no means identical. It is not

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* I have seen views of the staircase in the Museum in Berlin which were taken with wide-angled lenses. In these the joists of the ceiling are taken from below (frog perspective), while the statues on the groundfloor are taken from a bird's eye view; however, the public is satisfied; all they want is to have a picture with a great many objects in it; how they look does not matter. From this desire to see a great deal at once originated probably the mania for ascending mountains. Every one is delighted with the view from the Brocken (Harz Mountains), although it is bare of all beauty; but we see a great deal at once, although very little that is beautiful.

artistic when the objects in the picture are arranged with a stiff symmetry and mathematical precision; as, for instance, the sacred pictures of the oldest schools of painting; in the centre, we find the holy virgin, to the right and left each six apostles drawn up like soldiers of the line, and not only symmetrical in position, but also in the carriage of the hands, feet, and head; the left side of the picture the

Fig. 122.

Lessing, after Rietschel.

exact counterpart of the right. Art demands liberty and order, and this shows itself in an *easy symmetrical arrangement.* Man himself is a symmetrical figure; we can divide him into two parts, and the one

part would be the exact copy of the other; for example, a soldier making "front face," the legs together, the hands drawn close to the body, the head directed *vertically forward.*

A person will *only take such a position* when forced to do so, and it will lack beauty because it is unnatural. Let us contemplate a man standing in an easy position (Fig. 122); he will very seldom rest on both legs, like a soldier, but generally rests on one, the *supporting leg*, while the other is left free. Neither do both arms hang down, but he places them in different positions, and generally the head and body are turned in different directions; and hence it is that he appears, even in the lifeless picture itself, capable of motion, while the symmetrical soldier appears even in life stiff and rigid, and still more so in the picture.

What is applicable for a standing figure, will be true also for a sitting one. Here also a strong symmetrical sitting person appears ugly. The position is pleasanter if the head has a different position than the body (see Fig. 123), the feet different again from the rump, and arms, hands, and coat collar a little different position on each side, the head a little inclined. As much as stiff symmetry displeases, the more unpleasant we perceive a wholly striking unsymmetry like

Fig. 123.

Fig. 126, where the right side is empty, while the left, at all events, shows a superfluous table. Here that is missing which art scholars call the artistic equilibrium. In this condition of equilibrium, it cor-

responds to a line *b*, Fig 124, falling towards the right, on the other side one falling towards the left. Notice, for instance, the arm outlines of the sitting figure, 123, the seam of the coat in Lessing, Fig. 122. If the picture consists of all oblique parallel lines (Fig. 125), this equilibrium is not fulfilled, and this want is felt by the observer, although he is innocent as to the cause of it. See the picture (Fig. 126).

FIG. 124.

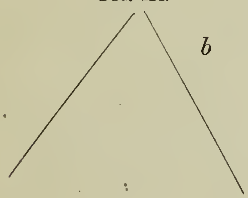
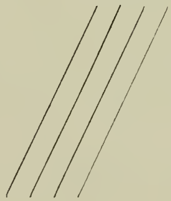


FIG. 125.



In the picture (Fig. 126), for which, and three others, we are indebted to Mr. Robinson's excellent work, "Pictorial Effect in Photography," a great many of the main lines run in the same direction. The legs of the figure, the chair legs, upper arm, coat collar, and the back of the chair, and not a single line which runs in a symmetrically

FIG. 126.

opposite direction; to the right we have an empty space, while to the left a vase and a table crowd the space and withdraw the eye from the main object. That the monotonous and unnecessarily parallel lines could have been easily avoided it is not hard to understand; but we must not think that we must avoid absolutely all parallel lines in a picture; we must leave what is an organic necessity, but we must

not unnecessarily increase them, as the author has done in the preceding picture, by letting both arms, both legs, the legs and the back of the chair run in the same direction.

In conclusion, I will give a sketch in profile, after Paton (Fig. 128). The balance has been beautifully maintained; the folds of the dress, which fall towards the left, find their symmetrical opposite in the lines of the arms, which descend towards the right. The shrubbery at the right finds its opposite in the two trees on the left; a few objects in the foreground on the right side correspond with the figure and give it an easy appearance. The few branches and the hat in the immediate foreground are not without meaning. They form, so to speak, the continuation of the lines of the arms, which incline to the right. When we cover the former by a piece of paper, the figure will at once lose its importance. If the child should stretch its invisible foot towards the right, the accessories will no longer be necessary.

Photographers have, of course, more trouble to produce such free symmetrical arrangement than the artist, for the stiffness of the persons sitting is often the greatest resistance to their endeavors. But

Fig. 127.

often it is not the fault of the model, but lack of taste and artistic posing of the photographer. We annex as a frightful example a picture of a dressed-up Turkish lady in Berlin, Fig. 127. At a dis-

tance it seems as though the figure was sitting with legs spread apart; on closer examination it will be seen that towards the left there is no leg but a drapery, no doubt placed there to fill up the empty space. This want of taste condemns itself. The figure is made to look more horrible by the kinked (paper?) breeches, and the placed-up leg, which can hardly be recognized as such, which besides cuts off the essential parts (the waist and elbow) of the plump posed upper part of the body. The artist is licensed, for producing the artistic equilibrium, to resort to draperies and requisites as his aids. The less he needs such aids the better for him, for they are horrible. When they serve as the balance for essential parts of the figure, as in Fig. 127, the left leg is balanced. Side objects, like draperies, etc., must not have the same artistic claim in a picture as the essential object. The essential object in a portrait is only the figure itself.

A piece of drapery thrown over the back of the chair of Fig. 126, and falling towards the right, would establish the artistic equilibrium, a trick which is cheap and very much liked. However, it would not remove the parallel arm and legs, but would only fill the empty space. The less an artist stands in need of these things the better he is off. That they are not absolutely necessary is demonstrated by the portrait (Fig. 123), which is copied from a picture by the world-renowned C. V. Jagemann in Vienna. The woodcut does not do justice to the original.

FIG. 128.

It shows symmetrical arrangement with full liberty of motion, and yet without resorting to draperies or accessories. In every arrangement one thing should be observed,—the arrangement must be free

and unrestrained. As soon as we notice in a picture that the artist has carefully pulled the clothing into the proper folds, that he has dragged furniture and draperies to his assistance in order to establish an equilibrium of lines, when we feel that the limbs and the material are forcibly squeezed into a position which they would never assume naturally, then the arrangement appears artificial and inartistic.

The portrait (Fig. 123), as well as the sketch by Paton (Fig. 128), show figures which rest on the broadest basis; forms which narrow towards the top, like a pyramid.

This pyramidal arrangement we find in numberless works of art. Why does this arrangement harmonize the best with our feelings? It is because the pyramid rests on the firmest foundation; and we demand a firm stand for every figure at any price, particularly in photography.

This is a point which requires particular attention with standing persons; they are not so easily brought within the pyramidal arrange-

Fig. 129.

Group by Bendemann.

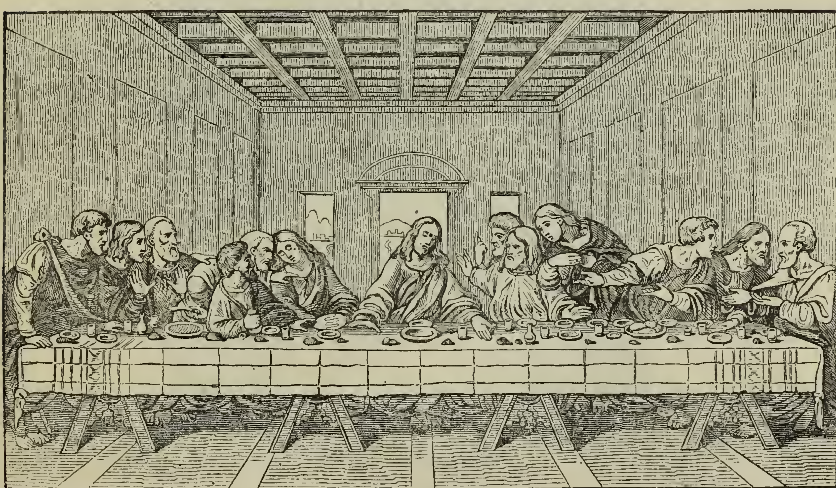
ment, and hence are easily in danger of appearing in the picture as if they rested on an insecure basis.

We not only find this arrangement on the basis of the pyramid for single persons in the works of art, but to a much larger extent for groups.

I will give as an illustration a group by Bendemann.

We see the pyramidal arrangement not only in the whole group, but the large pyramid resolves itself into several smaller ones; for instance, to the right the mother with the child; in the centre the boy with the jug, and where the stream of water accommodates itself to the pyramidal arrangement the lines of the right are the opposite of those of the left. The boy playing the flute comes under the same arrangement. We see here that two things of secondary importance serve to complete the pyramidal structure, but the less we rely upon or resort to such artificial means the better it is. Such accessories become perfectly horrible when they crown the pyramid. I have seen a picture of two sitting persons where the pyramid was formed by placing behind them a step-ladder. In fact two persons are apt to give the photographer much trouble in the arrangement, and even the sculptor has great difficulties in properly disposing of such subjects. As examples I would mention the Schiller-Goethe Group of Rietschel and the Luther-Melanchthon Group by Schadow. How easily two or three persons accommodate this pyramidal arrangement, is shown in the following instance, Mieris and his wife at breakfast (Fig. 132), a musical entertainment by Terburg (p. 343), a loving couple by Metzu (p. 345).

Fig. 130.



Leonardo's Last Supper.

The difficulty is still greater when a great number of persons has to be grouped together. This much is to be observed, the pyramidal grouping must appear easy and without stiffness; it must under no

circumstances appear as if made after a stencil pattern, in which every object is forced into a given form.

There are objects which are absolutely antagonistic to the pyramidal form. As an example we give "The Last Supper," by Leonardo da Vinci.

It would hardly be possible to arrange the thirteen persons who sat at the table in pyramidal groups. A horizontal arrangement is unavoidable unless we foreshorten the table. The nature of the case demands it. The picture shows how the artist disposes of a number of persons, and brings them all prominently into view. He proceeds like the naturalist. The latter, in order to make it comprehensible, divides a number of objects in genera and families, or smaller groups. In a similar manner the artist divides his persons into two principal groups,—six apostles to the right, six to the left; each of these two

Fig. 131.

Thorwaldsen's Night.

groups is again divided into two parts containing three persons each. But all the parts stand in a harmonious combination; they all arrange themselves in accordance with the idea of the picture. The arrangement obeys the laws of symmetry in the most perfect and easy manner.

There are works of art in which pyramidal composition was possible, but where it has been purposely neglected. Thorwaldsen's splendid Bas-relief, Night, is an illustration. With two sleeping children (Sleep and Death) the female figure floats down to the earth; around her forehead is a wreath of poppy, indicating sleep. We would have to force our judgment to find a pyramidal arrangement in this work of art. It would, in this instance, not only be superfluous, but it would also be without motive, for the figure does not demand stability (which is a characteristic of the pyramidal style), because it is not at rest; it floats in the air.

When the photographer has to group a greater number of persons he can easily combine the horizontal and pyramidal arrangements.

Fig. 132.

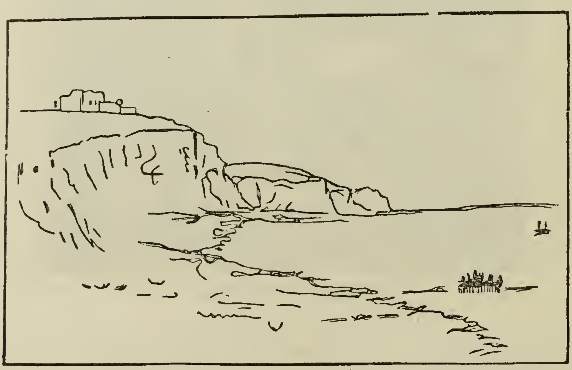
Mieris and his Wife.

He divides the numbers, as in Leonardo's picture, into several smaller groups (which, however, must not be disconnected), and tries, in each of the smaller groups, to do justice to the pyramidal arrangement. It will be difficult for him to create a work of art in this way. People are too unwieldy and too awkward, but he will succeed in making a

more pleasing group than if he placed all his figures stiffly side by side.

Often he can combine a number of persons by an action, be it playing at cards, dominoes, eating, drinking, looking at books or pictures, to the purpose successfully. The artist here follows his feelings, which will discern the right from the false very well. To cultivate this feeling, a study of the art-rules alone will not suffice, thereto the study of celebrated works of art, portraits, and genre pictures of old and new masters is necessary. Who, however, wishes to finish the cultivation of his form and line feeling, should delineate after antique models. Here the effect of outlines and lines are learned. One thing is yet to be considered. Much that in painting has an infinitely charming effect, would, photographed, have a quite indifferent one. Knauss painted his daughter, standing with both feet firmly set, in front of an empty dark background, looking at the beholder with her slate in her hand. The pose is as simple as possible. A photographer who would choose the same pose, for the same child, would probably be accused of want of idea. The painted picture, nevertheless, appears so infinitely charming, through the exquisite painting, the fineness of the carnation, the wonderful characteristic of the natural child-face, that the simple pose does not disturb the picture at all. The excellent painter has, without regard to the colors, namely, by the true reproduction of the characteristics (which is hard and seldom accomplished by the photographer), so much in his favor against the photographer, that he can among other things, slight his miserable expedients.

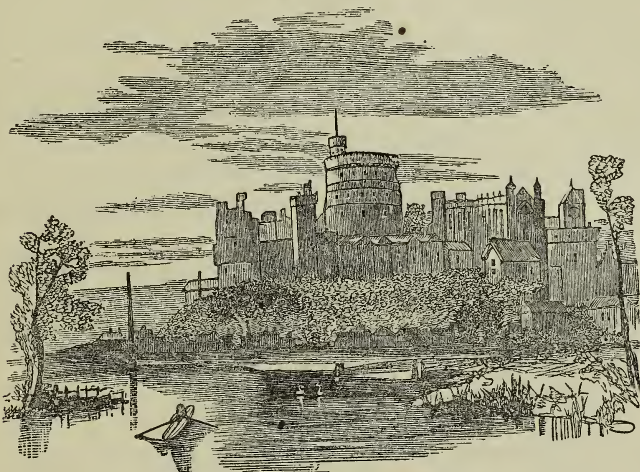
Fig. 133.



The arrangement of landscapes admits of much more freedom, as we have already seen above, in speaking of the sketch by Paton (Fig. 128). The shrubbery to the right finds its symmetrical opposite in the two trees to the left.

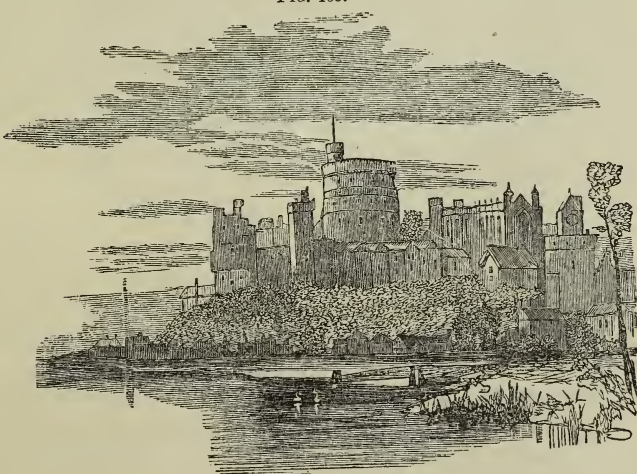
In the same manner in a picture of the sea, which intentionally has been enlivened by a boat or a ship, the latter effect must be balanced by massive rocks (Fig. 133). Clouds also are often happily employed to produce this equilibrium.

FIG. 134.



Accessories are of great importance. Very often the simplest things are of the greatest advantage. For instance, the accompanying pic-

FIG. 135.



tures (Figs. 134, 135), for which we are indebted to Mr. H. P. Robinson, the unrivalled composition photographer. The two woodcuts rep-

resent one and the same object, and correspond exactly, excepting the black spots,—the boat in the river, and the tree on the river bank, which in the one are wanting. In comparing the two we feel at once the importance of the black parts in the lowest point of the angle, which is formed by the perspective lines of the castle and the river. In the second picture, where the boat and the river-bank are left out altogether, the castle looks as if the foundation had been removed from under it. The lines, which run towards a distant point, seem to lack union and regulation; the distance enters the foreground, and the separate parts do not stand in the proper relation to one another. In Fig. 134, where the boat, tree, etc., are present, every part occupies its proper position, and we have a feeling of completeness which is wanting in Fig. 135.

I would advise the student to study with care the principal landscape pictures of our great masters,—Claude Lorrain, Schirmer, Lessing, Hildebrandt, and others. In all of them he will find interesting examples of what has been said above.

LINES AND OUTLINES.

Before photography was invented the so-called silhouettes were much liked as cheap pictures. They represented nothing but the outlines of the figure, generally in profile. Everything else was empty (as the treasury of the French minister (Silhouette) from whom these pictures derived their name). In spite of this emptiness the pictures were pleasing, and how much effect can be produced with them is shown by the recent silhouettes of Konewka, who really has produced charming pictures in this branch, and the want of filling up in his pictures is scarcely felt. This shows of how much importance outlines are. The influence is felt everywhere, not only in the empty silhouette, but in every picture.

Every thinking artist who desires to reproduce an object first studies its outlines. He allows his eye to glide over the lines, and tries to find the beauty of their curves. He follows the changes of the stronger and the weaker one, the longer and shorter, their windings, and easy combinations. Let us study, for instance, the outlines of the figures of the Madonna Aldobrandini by Raphael (Fig. 137), one of the most magnificent early works of the great Urbini, let us place alongside a similarly arranged, and according to photographic notions, successful children's picture, and we will feel at once the enormous difference. The vast public of course does not see such. It gapes at the faces with the remark, "A pretty face," or the opposite. A painting is refused that the artist has painted dress, draperies, form

of body, color, illumination, and shadow, and motion, with the greatest care, and not noticed. But not only the outlines speak in the picture, but the whole contour generally, whether it be formed by the limbs, seams, folds, accessories, or draperies.

I have already shown by Fig. 126 above, what an unpleasant effect is produced by parallel lines, or when the limbs are placed at right angles to each other, like the legs of a saw-horse. Just as ugly are zigzag lines. See, for instance, the Turkish lady (Fig. 127). The kinked breeches make up a zigzag formed, highly unpleasant effect, producing ugly outlines; add thereto the lines of the kinked pleats running to and fro on the surface, and finally, the decidedly ugly angle produced by the elevated leg on the supporting one, without

Fig. 136.

speaking of the ugly outline of the whole figure. In every artistically beautiful picture there exists a wonderful degree of harmony of lines, and even a photograph can do justice to this.

Let me again refer to the picture by Jagemann (Fig. 123). The edge of the undercoat slopes from the right hand upwards, and is continued in the line of the neck. The latter sweeps on the other side downwards, in the contour of the face and the forehead, and is finally lost in the edge of the same coat. The outline of the hand

which holds the book is, starting from the little finger, continued in the same elegant manner in the contour of the overcoat, ascends next to the throat, descends on the other side, and ends in the slightly curved index finger of the left hand, and almost voluntarily the eye

Fig. 137.

follows the direction of this finger, and continues the sweeping line in order to ascend again to the edge of the book, the thumb, and the contour of the inner coat.

This shows how several outlines may combine to form a main line, and how even the hair may follow the sweep of the curves.

I would now call attention to the "genre" style of Terburg (Fig. 136). We see the contour of the coat of the lady continued in the folds of the table-cloth, ascend to the corner, and continue in the right arm of the knight, continue again in the outline of the figure standing in the background, and thus gradually carried back to the lady. The back figure in the terzetto would, if placed by itself, not be free from objection. *It is a fault when neither arm nor leg resolves itself into outline, and when the head is squeezed in between the shoulders,* as in this last-named figure.

FIG. 138.

Such figures are bad unless the action represented should demand such a position. But in trying to give a sharply marked outline we can do "too much of a good thing," and instead of expressing calmness and dignity by a simple profile, we may, by too lively an arrangement of outlines, do exactly the reverse. We need not look

far for examples. There are thousands of portrait photographs, in which the calm and dignified features of an old man are represented by zigzag lines, lacking all the elements of beauty.

In its outlines, the picture by Jagemann (Fig. 123), may be called a success. Only one thing is annoying, the projecting back of the chair behind the left arm and the shoulders, which are drawn back too much, and give to the figure a weak appearance.

The lively outlines correspond perhaps with the character of the subject, but they would be ill-suited to an older person. A little more lively profile would be desirable for the female parts of the picture by Metzu (the lovers) (Fig. 138), but it may be objected that the beauty turns a cold shoulder to the caresses, and that the quiet outlines correspond exactly with her indifferent humor.

It is difficult to explain to any one fully the beauty of the lines. It is a matter of feeling. I can only call attention to the first-class masterpieces in painting and sculpture. For instance, the lines and general contour in the Madonna of Raphael (Fig. 137). In these wonderfully soft outlines, which look as if they were laid on the canvas with the breath, is such a charming harmony that everything which the photographer has ever made with his camera looks flat and weak compared with it. On such works the disciple of art may exercise his appreciation of outlines.

In landscapes also contour and lines play an important part. Even the ordinary admirer of nature distinguishes between elegant and clumsy outlines of mountains and trees. In architectural pictures many parallel lines converge towards the point of "disappearance;" they direct the eye to great distances, and even without such architectural lines we will feel, in a well-composed landscape, a certain harmony in the sweep of the lines, as, for instance, in the curve of the shore which is lost in the distance of the picture (Fig. 133); also in the contour of the mountains, all of which lead the eye to the same distance. Clouds are wanting in the above sketch; if an artist would add them to the picture their outlines would have to harmonize with those of the mountains and shore.

In the sketch of Windsor Castle (Figs. 134, 135) the outlines of the clouds descending to the right form a contrast with the contour of the architectural objects which descend to the left.

DRESSES AND DRAPERIES.

Our climate compels us to cover ourselves, as a protection against wind and weather, with clothing, the form of which is regulated by

sex, nationality, the age, and is also modified to a very large extent by the individual taste and fashion.

In general the modern dress consists of bag-like pieces, which are sewed or buttoned together—sleeves, pants, vest, coat—quite in contrast with the costume of the ancients, which consisted in simple pieces of some material which were thrown in picturesque folds around the body. At present the fop shows himself by the cut of his clothes, which correspond with the latest number of the journal of fashion. At the time when classic Greece had reached its height the greatest elegance showed itself in the beauty of the folds of the drapery. Pericles was celebrated for the manner in which he threw his cloak about his body.

We find the antique costume in numberless statues, and even where the figure is completely draped we can discern the form of the body distinctly. Shape and motion of the covered limbs are distinctly visible. To this principle, from which the ancients never deviated, our great modern artists strictly adhere, and where it has been overlooked the work will not even satisfy the common inartistic observer.

Our feelings demand motives. Why is there a depression in the drapery? Because underneath it is the cavity between the arm and the body. Why is there an elevation in the dress? Because it indicates the knee.

Fig. 139.

Madonna, after Van Eyck.

When we contemplate the (in itself) beautiful Mary, by H. Van Eyck (Fig. 139), we find the dress does not indicate in any way the foot, the leg, or the knee, and one cannot tell (at least not from the woodcut) whether the figure is kneeling or standing. No one will call such drapery beautiful.

To further show a photographic example, see the Turkish lady (Fig. 127), whose kinked breeches wholly hide the form of the legs contained therein, so that the elevated leg appears as a shapeless mass. Compare with this Fig. 140, where the forms are much more clearly indicated through the covering of the Madonna of Fra Bartolommeo. It is not difficult to perceive that one leg is kneeling, while the other one is stemmed in support. The position of the knee is clearly indicated. Even the heel of the left foot is plainly shown. Much the same arrangement we see in the arm.

How strictly modern artists conform to the rule that the folds of the drapery must conform to the forms of the body is shown by the fact that the sculptors first model their figures naked, and afterwards place the drapery on. Some modern fashions make this conforming of the clothing to the form of the body an impossibility in photography, as, for instance, the use of hoop skirts.

Fig. 140.

Madonna. after Fra Bartolommeo.

In such cases the artist must submit to the ruling fashion, for it would be wrong to persuade a modern lady, not an actress, to discard her crinoline in order to mark by a suitable drapery the position of the knees, the legs, etc. (The fashion alluded to is now changed, 1874.)

In the arrangement of the clothing and draperies, in so far as the

fashions do not interfere, attention should be given that the points of the shoulders, elbows, hip, knee and foot are recognizable, also the broad surfaces of the chest, the loins, etc. On the latter, depressions look very bad, while they are well suited to mark cavities, as for instance, between the body and arm, between the legs, etc. (Fig. 112.)

How important a part the drapery plays, in giving a more or less elegant flow to the lines, the examples which we have given above will show. Good artists are always anxious to modify the baggy and unyielding forms of our modern garments, by a piece of cloth or a cloak, in order to drape the figure artistically, and the more stiffness the fashion or the clothing prescribes the more excusable is the artist if he resorts to these subterfuges. In the soldiers of Rauch we generally find the cloak (Blucher, Scharnhorst, Gneisenau), the flowing lines of which agreeably contrast with the stiff lines of the uniform, and which splendidly mark the movements of the figure. Photographers in particular like to resort to these accessories, and especially the sculptor Adam Salomon, who goes perhaps too far in this respect, by giving to his sitters draperies unknown to modern fashion. Fortunately cloaks, havelocks, and Scotch plaids are the ready means at the hands of the artist to produce the desired effects; still better advantages are offered in the female costume, where arabs, shawls, veils, etc., supply a variety of draperies. But they should not be given to persons by whom the wearing of such articles is unusual, and who, perhaps, even protest against their employment.

It is not the purpose of photography to represent motion, but on the contrary a resting pose, and, therefore, it loses that important element of marking the forms of the body which the artist possesses in the flowing drapery.

It must not be supposed, however, that the artist can let the garments fly about at will, but their motions must have a motive, which we must be able to explain from natural causes.

It is the resistance of the air in Thorwaldsen's "Night" (Fig. 131) which presses the drapery to the form, and brings out the beautiful proportions.

Such motives we demand also in a resting pose. Byron, by Thorwaldsen (Fig. 141), has his cloak over the shoulders, in order to hide the right half of the body completely. The hand rests on the knee, and this causes the folds descending from the shoulder to be tightly drawn, which with the depression between the arm and the upper leg, plainly indicates the form of the body.

Frequently we help ourselves artificially by purposely pressing the draperies into the cavity between arm and body, or between the legs,

but such an arrangement has to be managed with exceeding care, in order to look artistic and not artificial.

The material of the garment plays a very important part. Starched linen and highly-finished silk give hard and unpleasant folds. Cotton is better, but woollen material is the softest and most harmonious.

The gloss, the color, and the thickness of the material, also require the most diligent study of the artist. For the painter color and high-lights are welcome objects to show his skill. The photographer is often driven to despair by their stubbornness, as the color is either ineffectual, or the high-lights produce ugly white spots. Salomon is right. Starting from the principle that the head should be brightest, he covers the light clothing which would make the head appear dark with dark drapery. He gives the preference to velvet drapery, not black silk velvet, but violet brown, or reddish cotton velvet. This material arranges itself in soft and well-rounded folds, while the high-light on the prominent points is gently moderated. A piece of dark crape or a veil is sometimes very valuable in modifying bright clothing, and has the advantage that the light dress shows through, while a dark drapery hides it completely.

Attention should be given to the parts without folds, and also to the elevated and depressed portions. The folds should flow evenly, and not be interrupted by numberless rumples, as is often the case when the garments have been in use for a length of time. I have seen a picture of Iphigenia, by Jagemann, where the classic robe was splendidly arranged, but where the many rumples disturbed the effect. The artist (painter or sculptor) leaves these things out, and he has a right to do so.

Folds generally do not run in straight lines, but appear on the curves of the body, or where the dress touches the floor, and the folds become broken.

Such breaks are very different in their nature; sometimes they are sharply cornered, sometimes more rounded, sometimes quite flat, and at others deeper. When they run in a zigzag line, backward and forwards, they disturb the feeling, and lack beauty (Fig. 139). The seam appears under as manifold aspects in our modern tiresome costumes; it generally is lost in monotonous lines, as, for instance, the seams of our coats, which are cut below in a horizontal line of almost architectural stiffness.

Still more disagreeable is the dress-coat, with the right-angled cut on both sides, which lacks all purpose.

But even in garments which fulfil the purposes of drapery much better the seam is generally neglected. The artist is often satisfied

with having produced a few artistic folds, and pays no attention to the lines of the corners.

Of how much importance these are, a glance at the seam of the drapery of Thorwaldsen's Night (Fig. 131) will show at once.

FIG. 141.

Byron, after Thorwaldsen.

Lively and animated at the feet, the upper parts sweep in various directions, and give rise to a charming play of lines. When such an animation of the seam is but an exceptional case in quiescent figures, and particularly difficult in our modern costumes, still the pictures of Terburg and Mieris (Figs. 136, 138) teach us that with all simplicity we can avoid monotony. The lively curve of the seam of the cloak of

Byron forms a pleasing contrast to the somewhat stiff and monotonous lines of his modern costume.

A peculiar kind of folds, which are particularly annoying to the photographer, are the folds which show themselves in our clothing after they have been in use for some time. They manifest themselves particularly in the arm and knee joints. They are elevations or indentations which are visible even in the standing figure, and which no pulling and twisting will remove. They are particularly offensive when they show themselves above or below the knee. Attention should be paid to these folds, and they should be placed at the spot where they properly belong, *i. e.*, at the knees or the elbows.

Sometimes a comical effect is intentionally produced by placing these folds in the wrong place, and by giving them a particular prominence.

The treatment which modern costumes require, in order to give an artistic effect, we can best learn from the works of modern masters. They should be studied whenever a chance offers itself. We should observe the contour, the folds, the surfaces, and seams. That is the only way to sharpen our judgment.

The hair requires similar management to the drapery, but in speaking of the hair I do not refer to the dropsical modern productions, consisting of chignons and other monstrosities, but refer to the free flowing natural article. I will not sit in judgment on every artificial curl, however. They are sometimes very acceptable in producing a picturesque arrangement.

The hair which hangs down monotonously without variation is like the drapery without a fold. The ancient sculptors enlivened it by pouring it into wavy lines. The effect is splendid when in nobly curved lines it flows around the head, descends to the shoulders, and harmoniously loses itself in the lines of the drapery. A hat with a waving plume or a veil will produce a beautiful harmony with the hair. The portrait painters of all times have known how to take advantage of this.

I might speak here of drapery in the landscape. Seriously speaking, what is the foliage of the trees other than beautiful natural drapery? The difference is that the trees wear their garments in summertime, while men don their most elaborate costumes in winter. Here also the æsthetic sense demands that the skeleton of the trees, the branches, shall be visible in the foliage. The elevations and depressions must find their cause in the disposition of the branches, and in this consists the difference between beautiful and ugly trees. In the

former the contour of the foliage gives us an insight in the structure of the branches, although the latter are not directly visible.

POSITION AND STANDPOINT.

(A.) *The Arrangement of Human Figures.*

In the chapter on arrangement I have already called attention to the fact that, in a standing human figure, the centre of gravity must not be lost sight of. In a figure resting on one foot the line of the centre of gravity proceeds from the throat to the inner ankle bones of the foot on which the person rests. If the lines fall outside the same, then the figure is not sufficiently supported, and should have a support against which it can lean. A position where the body rests equally on both feet the artist will very seldom select, not even for a soldier. But where a body rests on one foot (Fig. 144), and where the other has free play, the hip on the side of the supporting leg will be higher than the other. It will also easily be observed that the shoulder over the supporting leg is a little lower than the other.

The hip lines and shoulder lines are no longer parallel. Painters pay particular attention to this, and photographers should do the same. There are persons who habitually carry one shoulder lower than the other. Such persons should not be placed in such a manner that the body rests on the foot which corresponds with the lower shoulder. The natural fault would only appear exaggerated. The head appears more lively when it has a different direction from the chest. The eyes follow the head; for instance, if the head is turned to the right the eyes will take the same direction, unless they should look straight ahead. *In no instance* is it admissible, where the face bears a calm expression, that the eyes should be turned to the right while the face is turned to the left. *By a very slight turn or change in the direction of the head on the one side and the apparatus on the other, the outlines of the head may become completely changed.* The turn of the head is generally left to the photographer, and he generally prefers to direct the eyes to the shaded side. Artists, on the contrary, are in the habit of turning the head in the direction of the highest shoulder.

The free leg, in contradistinction to the supporting leg, is not limited in the choice of position. It can be moved forward or it may recede, but the position of the opposite arm depends on the position of the leg. We notice in walking how the left leg corresponds in its motions with the right arm, and *vice versa.* The right arm and the left foot are raised simultaneously in order always to maintain the

balance. But from an artistic standpoint it is likewise justifiable that the left arm and the right foot should move in contrary directions, so as to avoid parallel lines.

When the upper part of the "free leg" progresses, it is customary to let the upper arm on the other side recede and the forearm progress

Fig. 142.

(see the annexed figure of the Levite). Also, in order to avoid parallel motion, when one arm is raised the other hangs down by the side (see the annexed figure of the Pharisee). In short, the natural contrast in motion, which shows itself in walking, we try to maintain in the *quiescent figures*, and this enables the artist to give it an animated appearance. Artists pay attention to the smallest details, even in the positions of the limbs. In an outstretched arm the hand should have a different direction from the arm, and to the hand itself the most scrupulous attention is given. Next to the head the hand is the most expressive and interesting part of the body.

Beautiful hands are exceedingly rare, and the photographer is but too often compelled to show them as little as possible; but their natural ugliness is increased by an ungraceful position. Let us look at the hands by our first painters and sculptors. Every finger of the unemployed hand is independent and distinguishes itself from its neighbor by its motion, while in many photographs the fingers appear as if they were glued together (look at the figure of a grasping and supporting hand, Fig. 143; also the hands in the portrait, Fig. 141). We will also find in our master-pieces, without much difficulty, that the index finger plays a prominent part amongst the longer fingers of the hand.

Fig. 143.

It is difficult for the photographer to separate the fingers of his model. A simple expedient to give to the stiff fingers a somewhat more lively expression consists in placing a roll of paper in the hand of the sitter. The fingers will place themselves around this, similar to the portrait (Fig. 142). By gently removing the roll, the fingers will remain in a tolerably graceful position.

We must of course take the individuality of our model into account. It would be ridiculous to bring the horny hand of a laboring man or a washerwoman into such a position. The position of the hand depends of course upon the object that has been held by it. A light object, for instance, like a book, is seized in a playful manner, while a heavy one, like a lance or a spear, is more firmly grasped; but even here the index finger does not grasp as firmly as the others. To seize a light book in the same manner as a heavy weapon would appear comical; and to seize a heavy weapon as gracefully as a plaything would appear weak.

All that has been said in the above pages in regard to standing figures applies, the nature of the support excepted, also to sitting ones. Both legs are here at liberty. On account of the inactivity of arms and legs there exists a greater freedom of motion and of arrangement. Above everything else a parallel position of the arms, or of the legs, should be avoided. Fig. 126 furnishes a warning example.

With such representations photography has nothing to do; the representation of objects at rest is her province.

I must still call attention to the differences in age and sex. Children

and women are differently constructed from men. They stand and walk differently. The child, for instance, does not know a supporting leg nor a free leg, except in a highly developed state. It stands firm on both legs. The masculine body is firmer, more muscular, and less fleshy.

In women and children the soft parts are more developed. Look at the hand of a child. It looks like a cushion. The large size of the head of a child is well known. The oval of the male head is broader below than the female. The eye in women is located a little lower than in men; the ears and the nose are a little shorter, and the mouth somewhat smaller.

Of course there are numberless exceptions to this average rule, according to race, individuality, manner of living, and development from gymnastic exercises. Place a woman who has to make her living with her handiwork, alongside of a lady who spends her time in idleness. There are no two individuals exactly alike, and no one knows it better than the photographer. Let him try to repeat a pretty pose, with which he was successful with one model, with another person, and he will soon find the difficulties. It will not do, and in spite of all his care it will always turn out something different, even if the two persons look as nearly alike as can be. It is, therefore, generally speaking, superfluous to give rules for making positions.

I have repeatedly referred to the picture (Fig. 123) by Jagemann. The chest is turned towards the left upper leg. This gives a lively expression. It is increased by the turn of the head, in the reproduction of which unfortunately the xylographer has not succeeded. The whole figure becomes animated, which seems almost as if it were carried too far, but which in this instance corresponds exactly with the character of the individual. It would, however, be foolish if we would give a similarly animated pose to another person of a calmer temperament. Here *slight contrasts* are by far preferable. When a stiff-jointed old man places both his legs in parallel lines, we must admit that this is perfectly in order, and a quiescent turn of the head should be selected for him.

What has been said in regard to single persons applies with equal force to groups, for a group is nothing but a number of individuals. Yet in the arrangement of each single figure the complexion of the whole must be kept in view, and the building up of the group must be carried on in an artistic manner. The larger the number of persons, the greater will be the difficulty, and we have to add to this, that besides the artistic conditions, we have to take into account the optical difficulties, which require that every character should appear

on the ground-glass sharply defined and without any distortion; the latter compels us to adopt a circular arrangement, where the concave side of the circle is turned towards the lens. When this is done the marginal figures will appear sharp, as the whole picture is now flat. How much the circle must be curved inwardly depends entirely on the nature of the objective, which yields more or less curved pictures. How the groups are to be artistically arranged we have already shown above. With all pictures without exception clearness in the arrangement is demanded.

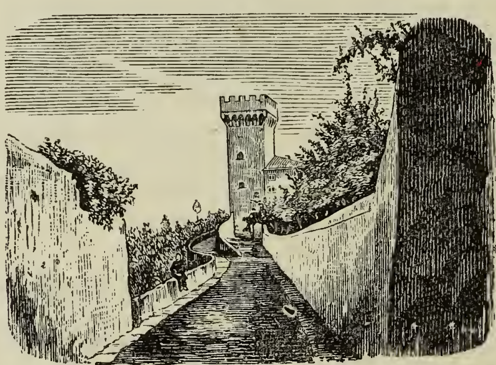
When in groups the hands rest on different shoulders, an arrangement much in vogue in student's pictures, and where one is at a loss to say to whom the different limbs belong, and when the legs of a group form a confused mass, we must call the arrangement confused. Such want of clearness very often happens also in single portraits, when, for instance, one hand lifts the drapery and causes characteristic folds; but when the lifting hand itself is invisible, we must call the representation devoid of clearness. It further lacks clearness when expressive parts are covered up. It is mentioned as a fault in the group of the Amazon, by Kiss, that the three heads—the head of the Amazon, of the horse, and the panther—cannot be seen from any side all at once. It is also a fault to cover a limb which performs a characteristic function. I know of a picture where it is intended to represent a letter-writer, where the writing hand is covered entirely by a superfluous book. It is also unpardonable when the supporting leg of a figure, which gives it a hold, is hidden or partially hidden by unimportant accessories; this is even annoying in lifeless objects, as a table or a pillar. But it does not follow by any means that all the legs must be absolutely visible. For instance, in Raphael's "School of Athens," which is very rich in figures, the covering of the less important figures by the more prominent ones in the foreground is explained by the nature of the case.

(B.) *Arrangements in Landscapes and Architecture.*

In photographing landscapes we can very seldom arrange the object to suit our desire. We can, however, obtain from the *same* object extraordinary changeable pictures, by changing the point of view, and awaiting a more favorable illumination. The choice of the point of view (or standpoint) is the main point in landscape photography. If you visit a strange region or quarter it is quite unnecessary to take the camera along on your first visit. Having chosen your object, and convinced yourself that it would make a good picture, study it

as a painter would if he wants to paint it, notice the best time of the day, visit the place several times during the day to note in what manner, in the position of the sun, light and shade changes the shape of the masses. Very often photographers commit a mistake by making exposure when the sun is directly at their back, *i. e.*, having the sun in its greatest illumination; they do not consider that they require shadow as well as light. Some objects require a lighting from the side, while others look better with the sun back of them, the rays tipping the edges of the mountains, a building, or trees. After the object has been chosen, the standpoint is selected. In this the camera can be taken along. All objects not in harmony with the character of the scene had better be removed; often a removal of the standpoint a few steps will suffice, or raising or lowering the apparatus. Twigs and branches of trees in the foreground can only be removed by cutting away. An indifferent foreground can also be cut away in the finished picture. Very important here is the choice of lenses; lenses of short focus and large field of view (pantoscope, wide-angled aplanatic) produce the foreground and the objects in the immediate vicinity very large, whereas the distant objects are very small (Fig. 145). Lenses of longer focus produce the distant objects larger, without the large foreground and objects in the vicinity

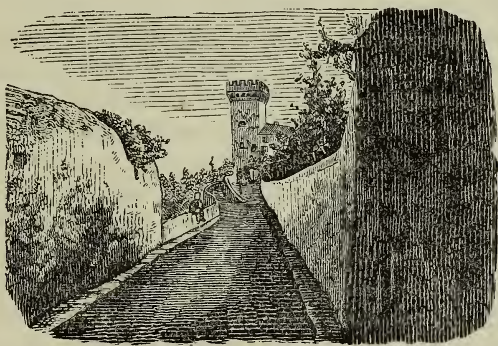
Fig. 144.



(Fig. 144). According to which is the most important to the operator, the immediate vicinity or the distance, he will select from the same standpoint his lenses for long or short focus. In the photographs of the annexed pictures of the same object, the one which was taken with the long focus (Fig. 144) is the best, for it shows the tower

large and at a proper distance. The one taken with a short focus (Fig. 145) shows more of the road and the side-wall in the foreground. These do not add to the beauty of the picture; the tower, however, appears small, and looks aside of the large foreground as though it was a half-mile away. Parallel lines produce in landscape an equally

Fig. 145.



unpleasant effect as in portraits. When the horizon is bordered with a straight line, the middle or the foreground should be wavy. This is easily accomplished by a change of the standpoint, which is necessary to produce a perspective view of the foreground. A motion of a few metres often changes the lines of a picture altogether. The front view of an object is seldom as picturesque as a perspective. Strong symmetrical pictures have the same effect in landscapes and architecture as in portraits. If, for instance, the nave of a church were taken from the centre of the choir, such a picture would be obtained. The exact repetition of the receding pillars on the opposite side would appear monotonous. This is avoided by taking a position outside of the middle. The same remarks are valid for innumerable cases. A lengthy view of a mall, a stream, or a street must not be taken from the middle if it can be avoided.

A picture must always have a proper close. For instance, the centre of a vault or arch must not be cut off or left without a support; better close at one of the pillars. The fancy of the observer could possibly imagine the missing support; it is, however, well and good to have it actually represented in the picture. Doubts often arise in what position to place the horizon. The following rule can be applied: the horizon line must not be at equal distance from the

top and lower part of the picture, *i. e.*, the surface must not be equally divided into earth and sky. This can be accomplished by raising or lowering the standpoint of the camera, or inclining towards the earth or sky. It must be, however, observed that perpendicular lines run together under such circumstances (see p. 328). The effect of the heightening of the standpoint on the foreground has already been discussed in the article on perspective. The foreground must never be filled with anything to draw the attention away from the main object. Perfectly horrible are crowding gapers. The sky is always troublesome to the photographer. Seldom a nice and fitting sky is found above a landscape, notwithstanding that the representation of natural clouds presents no mechanical or chemical difficulty. There is here nothing left but to await a fitting sky; take it and print it in separately, or to sketch a sky on the negative with lead-pencil or india-ink, either on one side or the other. Many cover the whole of the sky, so that it does not print, and then let it color up in the light, so that the horizon is the lightest, and the top the darkest. For this purpose place the print, print-side down, on a dull black body, pick up the sky-side so that the light may strike it, and let it darken.

CHARACTERISTICS AND INDIVIDUALITY.

We have spoken repeatedly of characteristic features, motions, limbs, etc., and the reader will ask, What are characteristic signs? I call all external signs that are *necessary* to a *true* and *comprehensive* representation characteristic.

For a letter-writer the writing hand is of course characteristic, even when it is not in the act of writing, but is merely lifted while the writer is in a contemplative mood, and the representation would be faulty and incomprehensible if this hand were hidden, even if the figure were surrounded by piles of paper and rows of inkstands and sandboxes. Sometimes for a clearer definition of the characteristics of the subject other marks have to be added. How, for instance, could we characterize a wine-drinker without a glass, a gambler without dice or cards? Some people think that they can get along with these accessories alone. We have, for instance, a representation of young Bacchus, with lifted and foaming champagne-glass, but alas! the face is cold and dry; the model shows that it is nothing but a model, and the features indicate that the fluid in the glass is nothing but small beer.

Such a representation is not only difficult to understand, but it is also untrue. A woman who folds her hands does not pray unless the

expression of her face indicates this. This holds good also for ordinary portrait representations. Observe the photographic portrait taken with top-light (page 303). The fierce-looking eyes and the heavy compressed lips are false indications, for they indicate a temperament which the man does not possess. Neither does the front and side-light illumination give the character of the person. A great artist needs very little to indicate the character, but the photographer often requires a great deal. That is the distinction between art and photography. The painter pays attention to the characteristic points only, while he modifies the others or leaves them out entirely, and the mechanically working photographer produces everything, even the minutest trifles, with equal distinctness.

Nearly every person has his own character—*i. e.*, his own principles of action (some, however, have none whatever). Some act without any forethought, quite unconcerned about the consequences. They think lightly of even the most serious things, and look on everything from the most cheerful standpoint (optimists), while others again look always gloomily into the future (hypochondriacs).

But in a picture we must represent the true character of a person, which can be done in a twofold manner. We either represent the figure at rest (as the statue of Lessing), or we represent it in action (Luther). It has often been said that the portraitist should not paint action. This is very true ; but when action contributes in such a weighty manner to rendering the character of the person, as the features in Rietschel's Luther (Fig. 146) indicate, our objections are hushed in admiration. It seems as if this man of metal, this giant mind, thunders to every one his "Here I stand. I cannot do otherwise. God help me. Amen."

When Luther here as a hero stands divinely grand before us, we must say that this representation is justified, even when we are told that he did not wear the gown, but was simply clad in the costume of his monkish order, with his head shaved according to its regulation, and that at that time he was as thin as a match. If Rietschel had confined himself closely to these facts, he would have represented an Augustine monk, but not a Doctor Luther. Rietschel in his representation of Luther has departed from historical facts, but gained largely in characteristic effect.

The artist often has to struggle long and hard to find the characteristic representation of an historical or mythical figure. For centuries they struggle, and always in vain, until at last a god-inspired genius seizes the problem and solves it in such a forcible and convincing manner, that the form becomes a model and an ideal which

is imitated over and over again, until finally it becomes the *type* of the character. So the Zeus and the Athene by Phidias, and the Hercules by Lysippus.

FIG. 146.

Few people have features which clearly and unmistakably represent their character. Physiognomists are badly at fault. I know persons whose compressed lips have something sly and malicious, whose small greenish eyes have something false and treacherous in them, and still they are the best and most amiable persons, whose character and life are without fault or blemish. While, on the other hand, persons with open and noble countenances, who at first sight

will win the confidence of every one, very often prove to be the greatest rascals. A great many people run about whose faces are living lies. They enter the studio of the photographer and he shall make a picture of them which not only gives the outside appearance, the likeness, but which also indicates his *character*, which latter often contrasts in the most heterogeneous manner with his outside appearance. Few persons are aware how much belongs to the *complete* representation of a person.

Some appear charming when they talk, sing, or gesticulate. Some represent themselves only to advantage when they are in company, with a large circle around them listening to their witticisms. Some are only gay and lively in ladies' society, while others again show best in male company. Some people appear dark and gloomy in the room, while they are lively and amiable in the open air. The honest countryman feels depressed and embarrassed when he treads the elegantly carpeted floor of the richly furnished atelier, but he is happy in his humble cot. All these circumstances, however, have their influence on the appearance of a person. The portrait, no matter how good it is, will only give an *extract* of the character. It may appear a speaking likeness (scarcely a singing one), but it will only give partial satisfaction, as the accessories which the original requires to produce its whole effect are wanting. The painter, who knows his original, does not always succeed in this; how much more difficult must it be for the photographer, who has to represent a perfect stranger, who sometimes intends to leave in the next train, and who in his whole behavior shows so much hurry that he would make a good representation of Mercury with winged sandals on his feet.

To this we must add the circumstance that a great many do not care particularly for a true representation of their character. The rascal wishes to appear as an honest man; the lady passing into the sear and yellow leaf of autumn wants to be young and coquettish; the servant girl wishes to represent the mistress; the daugher of the mechanic wants to look like the court lady, and the street-sweep would be a gentleman. So do their pictures serve them as a gratification of their personal vanities; and in order that they may appear very fine and extraordinary, they put themselves into their own (and sometimes borrowed) Sunday clothing, which sits upon them as uncomfortably as possible. They practice before the glass, consulting papa and mamma, wife or sweetheart, on artistic, impossible pose. Even educated persons have such "cranky" notions. Thorwaldsen relates of Byron, who visited him to sit for his bust, that "he placed himself in the

chair, but the moment I commenced to work his features changed. When I called his attention to it, he remarked, 'This is the true expression of my face.' I made no reply, but finished his portrait as I saw proper. Everybody declared my bust to be a perfect likeness except Byron himself, who exclaimed, 'The bust does not resemble me; I look much more unhappy.' He wanted at that time to look very unhappy," continues Thorwaldsen.

The photographer is much worse off than the sculptor or painter. Suppose Byron had gone to a photographer and placed his woful face before the camera. What could the photographer have done? Unfortunately he has at the decisive moment to depend on his model, and how often his model at this critical moment disappoints him, not always from ill will, but often from nervousness.

Much depends on the photographer himself, who should understand how to govern the public in an amiable manner, for the treatment of the public is no unimportant part of photographic æsthetics.

Generally speaking photography has to represent objects in a position of rest, and only occasionally do we find representations of still life, where the figures are employed in a harmless activity, be it reading, writing, or contemplating a picture, mechanics at work, musicians performing on instruments, or children at play. In representing such objects the photographer can only seize a certain moment, and it is of the greatest importance to know how to decide which moment to choose. Not only artistic arrangement has to be consulted, but contour and harmony of lines must be studied. Take, for instance, a smith wielding the hammer, or a sculptor with his chisel. He places the chisel on the block of marble, lifts the hammer above his head, and with a heavy stroke it descends on the chisel. It would appear very weak if we would represent this last moment, when the hammer touches the chisel; far much truer, more lifelike, and comprehensible would it be to place the hand with the hammer above the head in the act of striking. In the simplest motions, even in walking, we observe similar deepseated differences. Not every phase is equally comprehensible. Many no doubt have seen the walking figures in instantaneous pictures, where the one leg is stretched forward in the act of stepping. Although this motion is entirely natural, and forms a part of our motion in walking, still it does not appear characteristic, but almost comical; it rather gives the impression of a military exercise.

Our walk is rather a complicated motion as simple as it may appear to us. We step forward, the weight of the body rests on the for-

ward foot; at the same time we elevate the heel of the other foot; we lift ourselves on the toes of the rear foot, and give the body a push forward, which is the real cause of the forward motion. When this has been done, we force the rear foot forward, and the same thing is repeated over again. Of all these different movements, the one which causes the forward motion is the most interesting—*i. e.*, where the toes of the rear foot push the body forward, while the forward one rests firmly on the ground and supports the body. And this is the position which artists select in the representation of walking figures. It is on the one hand the most characteristic, while on the other it gives the firmest position to the person so represented.

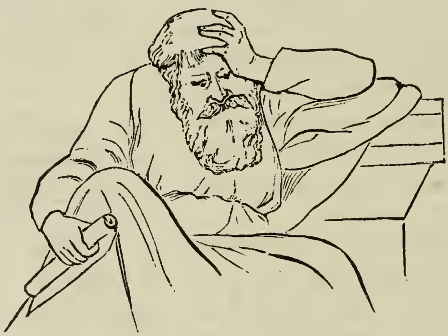
FIG. 147.

(See Thorwaldsen's Triumphal March of Alexander, Fig. 147.) A number of walking figures are here represented, and one would have supposed that for the sake of variety the artist would have selected different phases of the walking motion, and still we see all the figures in the movement where the rear foot is in the act of being lifted from the ground. Something similar we find in Konewka's Scene from Faust. Only the two soldiers have a very characteristic and for them suitable military walk, with both feet stretched forward. Solemn processions characterize themselves differently. In the triumphal Frescos of the Parthenon, the female figures step on both feet. It shows how difficult it is to characterize even simple motion in the picture.

The characteristic representation of mental condition is still more difficult. Foerster calls attention to Bendemann's Jeremiah. (Fig. 148.) The intention was to represent a person deeply grieved; but the circumstance that the hand does not support the head, but simply pushes it sideways, gives to it more the character of an angry person, or one that suffers bodily pain.

The same author remarks very pertinently, "How unnatural the picture of a praying person would be who would not bend her head downward, but hold it stiff and vertical, and where the hands only lightly touch each other, instead of being folded." Such figures remind one of the coquettish sinners, who go to church as a place of rendezvous, and who show that they care more for their surroundings

Fig. 148.



than for the worship of God. Such studied positions are very common in the photographic representations of real life. The models feel their importance, and it is very difficult to prevent them from taking affected positions.

Care should be taken with actors and actresses, although these are very estimable models. On the stage much can be well excused. Even a movement, which is not exactly beautiful, does little harm, as it occupies but a few seconds of time; but it becomes horrible when it is immortalized in the picture. Pictures of "mimics," who, when they wish to remove a glove, stretch out the arm as if they were pulling the sword of a giant from its scabbard, appear absolutely ridiculous.

Finally, I wish to call attention to how much the drapery is dependent upon the motion. For instance, see the person playing the "tuba," in Thorwaldsen's Triumphal Procession (Fig. 147). In consequence of inertia on the one hand, and the resistance of the air on the other, the garment in walking will fly backward.

We find something similar in the modern costume. Nothing shows more untruth than a photograph of figures apparently in motion where the drapery hangs down to the body. Such motions, which to characterize them require flowing draperies, are not suited for photographic representations. When the photographer wishes to represent motion, he should choose close-fitting garments for his figures. This is the reason why the photographs of mimic artists or ballet dancers appear in a measure dead-like and rigid, when it is intended to represent them in action.

But whatever may be chosen in order to give character to the object, everything that is not in itself beautiful should be avoided. The antique artists have never represented a fury, says Lessing, and the head of the Medusa, whose horrid countenance was to turn everything into stone, looks yet beautiful.

The beautiful cannot be learned by heart, as a rule in arithmetic. The feeling for it is a natural gift, and study can only develop it. It cannot create it. There are plenty of photographers whom nature has sadly neglected in this respect. They may learn at least what they will have to avoid, from what I have said, and when they feel that they cannot create, themselves, they should take examples of acknowledged value as their patterns.

While the mental peculiarities of a person are compounded together in character, individuality is understood to be their bodily peculiarities. There are certain proportions of the height and breadth of body, size of head, size of mouth and eyes, which make the pleasantest impression, proportions which for artists have by long study become standard, which are called normal, which in fact seldom occur. The deviations from the normal proportions make up the individual difference. One has a somewhat longer nose, a larger mouth, closer-placed eyes than another. Every individual shows such deviations, some more, others less. We must here remark, that that which in ordinary life is called beautiful, often does not show the least trace of those beautiful proportions admired by artists, which on the one part is based on masses, on the other in noble lines and outlines. What the novice calls beautiful can rather be called pleasing or pretty. Girls that pass as beautiful often have striking disproportions, which the untutored eye of the novice overlooks very easily in judging. The charm of a so-called beautiful face often lies, not in the form, but in the color of the cheeks, eyes, and hair, the grace and vivacious exchange of looks, the roguish smile of the mouth and eyes. All this has nothing to do with a beautiful form, and as such charms as do not lie in the form are often very hard to re-

produce by the photographer by such models, he has trouble. Petsch says:* "With a normal person, *i. e.*, with one that is bodily and mentally well formed, we will have little trouble. The picture will be set up by novices as a pattern for us, even if it is not a technical success. The very smallest number of them are normal, nearly all have some defects, not beautiful, bodily as well as in their behavior, and these peculiarities are those which cause us so much annoyance, and in many cases failure. We are certainly not in the wrong if we excuse these shortcomings. Surely it is more ingenuous to say, 'Be as ugly as you may, my art shall show what can yet be made of you.'" It is very easy to explain why blondes appear to be slighted. Their charm lies often in their color, in which, in nature, the irregularity of feature and homely form are overlooked, and these are just what are retained in photography. Deformity and ugliness of figure is, alas, in a greater or smaller degree, the object of our daily study. Crooked persons we shall make straight, stout ones slim, thin ones stout, etc. To be brief, all infirmities shall be covered up and silenced. To attain this we must above all be assured of perfect freedom in regard to the position and the style of the picture. Herewith much is accomplished; bust pictures are mostly recommended in an ugly figure, if the head is interesting enough to take exclusively. If this is not the case, another method must be tried. A very stout person I would take standing, from the knee, cutting the figure off pretty low; this will make it appear more slim; a slim one in the opposite manner. By buttoning or unbuttoning the coat, similar effects are attained, also in the color of the dress. Black appears tall and slim, white stout. With decorations, there is also much effected. On the person itself, with lace, handkerchiefs, cloaks, etc., much can be covered, and the attention drawn off by fine arrangement of the background, and the whole made to appear interesting. If in this style of picture, the head has a less unassuming effect, it is generally the case in large heads, which take up all the room on the card. These are only suitable for wholly normal or very interesting heads. Even then it must be decorated with secondary work, and very effectively illuminated. Many irregularities of the head can, by a dexterous use of the proportions, be equalized. Of all, crooked noses occur the most frequently. Such are the most striking in a front view; this, of course, should be avoided. Take the head from the side showing the smallest surface of the nose, so that the larger will be in the shadow. Almost as annoying is a crooked mouth, *i. e.*, such a one that is not

* Photograph. Mittheil., vol. 7, p. 138.

parallel with the intersection line of the eyes. The rule here is, even in profile, to take the side with the highest part, bringing the lowest in the shortening. In crossed eyes there is no alternative but to take the head profile. The arrangement of the hair is of the greatest importance, especially with ladies; very few understand the styles that suit the shape of their head. They follow the fashion blindly, all the same whether they have long or short necks, broad or narrow faces. Here it is the place of the photographer to advise, if necessitated, to step in and aid himself. A broad face appears with hair arranged sideways or deep still broader. A too long neck, with high stuck hair looks horribly thin, while a few falling locks would cover the defect. A high forehead, in males a mark of beauty, is in females the opposite. Many ladies can skilfully cover this with short locks or curls.

In a profile picture it must be observed, that the back part of the head does not appear too flat by the insufficient hair, or being pressed too smooth; a little loosening will obviate it. Ladies with a short neck must not make it shorter with high standing frills or ribbons; for ladies with short waists, short jackets are recommended, which make the waist appear longer. Short figures appear still shorter with a trailing dress. The hands are next to the head in importance. They are the cliff on which the beauty of many pictures are wrecked. The effect of large and ugly hands must be overcome by taking a bust, or if this cannot be done, improve and reduce them by the position. This is done by crossing the arms, placing them under the coat, or lapel, or making a shortened view.

We have seen in all these cases, that opposed to outward peculiarities, there is a remedy or at least alleviation. It is more difficult, however, to master the obstacles which are produced by the natural mental peculiarities of the model. One of the greatest inconveniences is the impossibility of keeping quiet during the exposure. Never be persuaded to take a picture without a head-rest. Place them in a very simple sitting position, with a full opening very short. A second obstacle which frequently makes its appearance is stiffness, awkwardness, a spasmodic holding of the limbs. Persons affected with this peculiarity must be made to understand above all things that the necessary quiet is not obtained by straining, but by easy leaving themselves go. In the awkward, nothing particular should be attempted, but leave them rest somewhere in a model position, in which, as is known, every one can place himself at once very easily. Embarrassment is dispelled by a quiet, friendly demeanor, some humor, and the admission of a friend in the operating-room. A cer-

tain class of persons are very unpleasant, who, while sitting, think of this and that, and then commence pulling the cuffs out a little, fix this pleat, look at their boots. Of course from each of these movements, that attained in the position is spoiled, and it begins anew the moment the plate is ready, and the exposure should commence. For such mistrusting behavior, beware of getting angry, but make them previously understand that not only during the time of exposure, but for the whole sitting, they must keep quiet. We are often asked why the pictures of actresses are so much better than the ordinary citizen public. It is not the greater beauty of these persons that produces this advantage. They bring us a selection of toilet articles, flowers, curls, even plaids, and allow us to arrange them, and decorate them, according to our fancy, to heighten the beauties and cover the defects. How different it is with our good-natured public. As they show themselves daily in a very tiresome dress, they want to be photographed. If you wish to add a piece of stuff for decorating, aye, even to change the position of a curl, they will at once remark that does not suit them, or they do not wear them. Besides, many have not the ease of motion, or understand our intention, through which the actresses aid us materially. Instead of being employed, in an artistic and technical relation, in doing our part, the most of the time is used to conquer the peculiarity of our model. We have seen how difficult it is to overcome all these obstacles in the short time of taking a picture. The portrait photographer must possess not only artistic and technical knowledge, but also the art of intercourse and sociability.

THE TREATMENT OF THE PUBLIC.

Many persons have a great aversion to being photographed. They compare it with a visit to the dentist or the barber, and many a one would much rather be for half an hour under the hands of the latter than under the care of the photographer. It frequently happens that a person will resist the importunities of his friends for years, and finally walk to the gallery like unto a place of execution. Others, and to this class the ladies belong in particular, have no such strong aversions, but they are timid and nervous when they enter a glass-house, and are not in a condition to make a good picture. Nervousness is by no means confined to the handsome sex, or to the old and feeble. Young and strong men get sudden attacks before the camera, and brave officers and soldiers, who would steadily march up to the cannon's mouth, will tremble before the photographic lens. They can no more stand still than any one else.

As this feeling is so widespread, the artist should attempt to dissipate it, and try to make things pleasant to his customers. The few introductory remarks on the arrival of a visitor he should try to make as agreeable as possible; neither too familiar nor too humble, but in the light and easy manner of the gentleman. During the preparation the same easy and polite manner should be maintained.

Under such a treatment many persons will lose their nervousness, and instead of having an aversion to the operation, it will afford them pleasure. This shows itself in the pleasant expression of the portrait, and in the carriage and quietness of the original.

It is probable that many photographers have never thought of the importance of such a treatment, and they must blame themselves if people do not like to visit their establishments. A rough and violent or impolite and affected manner, we frequently meet with among our colleagues. Many photographers will call out, when everything is ready, "Please look at this point; but make a little more amiable face." A lady will not be pleased with such an expression, for it indicates that so far she has not looked amiable, and after so *polite* a request she will not look any better. "*Not quite so serious*," would be less offensive. Much also depends on the manner in which it is said.

Another point which severely tries the patience and good humor of the photographer is the head-rest.

His sitters, almost without exception, misunderstand this object, and dislike it. But head-rests are necessary, and it requires tact, firmness, and good humor in insisting on their use. The general remark is, "I will look better without it. It only makes me look stiff." The best answer would be, "You may perhaps feel stiff, but you will not look so in the picture." It is the general custom to request the person to look steadily at a certain point, and it gives a calm expression to the whole face.

Sometimes, and particularly during a long exposure, the expression will change during the thirty or forty seconds of time, and pass from a pleasant smile to a melancholy look. Many a photographer opens his lens on a laughing seraphim and closes it on a fallen angel. It is, hence, necessary to caution the sitter against changing his expression. The corners of the mouth are particularly liable to this change.

Sometimes people will insist on having their pictures taken in unfavorable weather. They demand a trial, although the photographer feels perfectly convinced that it is but a loss of time and useless, and that success is impossible.

The photographer should remind such persons that it is in their

own interest to postpone the sitting, that it would only give them unnecessary trouble, and that he has no selfish motive in making the request. Some people will bring a friend along, who wants to represent the *artist*, and assist in arranging the sitter. A young lady, for instance, will be accompanied by a young gentleman—a brother perhaps; perhaps somebody still dearer—to whose judgment she appeals while the photographer places her in the proper position. The young friend commences to give advice how and in what direction his protegée is to look, generally requesting her to look steadily at a given point long before the photographer is ready. To a good photographer such an interference is unbearable. He finds his presence ignored, his place usurped by another, and feels that no confidence is placed in his artistic feeling nor in his skill. Here it is necessary to maintain your position, and to declare in a firm, collected, and polite manner, that either the photographer or the friend must withdraw. That a division of labor is not admissible, and if the gentleman wishes to make the arrangement, he may do so, but the photographer will not answer for the result. This has generally the desired effect, and the friend, who perhaps never intended to become intrusive, will generally withdraw.

Occasionally some one will insist quite obstinately that he wishes to be taken in a "comfortable" position. People often think that everything which is comfortable must be naturally graceful and beautiful. They throw themselves into the chair in a position which on the picture would give to them the legs of an elephant and the head of a dwarf. When such people are stubborn, it is best to let them have their own way. They will not try it a second time.

With all these trials and vexations to which the whims of the public expose the artist, it is not always easy to keep an even temper, and still he has to do it for his own sake and for the sake of his customers. It is not surprising that sometimes the stupidity of his clients puts him in a bad humor, for there are occasionally extremely provoking cases. A lady, for instance, will return her cards without stating any reason, and after repeated inquiries she will state that she does not like the position of her hat, or that a curl should fall forward instead of backward; another will complain of the position in which she has been taken, and threatens to bring her husband along the next time for the sake of keeping control.

Another unpleasant kind of customers are those who want to be photographed with small dogs on their laps, or large ones by their side; but worst of all are small children. These little screamers are generally accompanied by papa, mamma, and nurse, who all come to

"help" the photographer. The scenes which at such times happen in the atelier would be amusing if we would not lose our patience.

It is very necessary not to keep our patrons waiting too long if we desire to keep them in a good humor.

Waiting under any circumstances is a tiresome business, and many a picture shows but too plainly the long waiting to which the model has been obliged to submit.

Any one who has a flourishing business will do well to make an appointment with his patrons beforehand. Care should then be taken *that everything is in readiness.* Whoever commences to make the developer or even the silver-bath when the public is waiting will soon lose his custom.

Messrs. Loescher & Petsch prepare the plate the moment the model enters the atelier (the arrangements about the style of the picture having been fixed beforehand in the reception-room).

In the few moments of conversation which precede the taking of the picture, the photographer should have sufficiently examined his model and formed his conclusions about position, illumination, arrangement of dress, background, and accessories. He must at once arrange the pose while his assistant arranges the camera and brings the lens in focus. Only when the plate is ready the rest should be gently adapted to the head (not the reverse). With a quick glance the whole arrangement should be examined to see if illumination, outline, drapery, and background form a harmonious *ensemble,* and then the work should proceed at once without delay.

Any third party, or any noise in the adjacent rooms, running to and fro, etc., is an annoyance.

It is inconsiderate in the extreme to place the person in the head-rest, and to let him wait for the plate, or to lose half an hour in making the proper arrangement, and to change the position over and over again. The person will feel that the photographer does not know exactly what he is about, and will lose confidence.

Children should be taken very quickly. Success with them is in a measure a matter of chance. The light should be strong, the lens should work rapidly, and while the artist draws the attention of the little one by showing a toy or some bright object, the assistant should remove the cap the moment the child sits quiet.

Any one who has much intercourse with children will soon learn their little peculiarities, and by adapting himself to them he gains their affection, and they willingly obey his arrangements. This is the reason why a friend of children like Mr. Petsch is so successful with them.

FILLING THE PICTURE.

ACCESSORIES AND BACKGROUNDS.

In photographic practice certain sizes have become standard, and they are ordered over and over again. Particularly is this the case with the carte de visite size, and also the cabinet size. Both these sizes are dependent on the lens and plate-holder of the camera. The photographer has to see to it that the space is properly filled.

When, in 1858, Disderi, in Paris, invented the carte de visite, and by it gave an enormous impulse to photography, he recommended to take full-length pictures as being artistically most justifiable, as figure and deportment are necessary to the characteristic of an individual.

Photographers generally made whole-length figures in the beginning, and only here and there a bust or $\frac{3}{4}$ size would make its appearance. It did not take a great while, however, and busts became more and more in vogue. The public liked them. The reason is obvious. A picture in which only the head and chest are visible cannot be spoiled by a faulty arrangement of legs and arms, nor by an ugly arrangement of accessories, as too often happens with full-length pictures. So far as the æsthetic element is concerned, their production is easier and surer.

To this must be added other advantages. The larger dimensions and the greater prominence given to the most characteristic part of the human body, the head. Delicate details in the features, which in the small full-length picture were only visible with a magnifying glass, become strongly marked (sometimes too much so) in the bust picture or vignette.

On the other hand, individual shortcomings and faults in the illumination, which would scarcely be noticed in the full-length picture, became quite apparent, and it was reserved to a later period to remove them.

Since this size has become quite fashionable, various experiments or improvements have been attempted by enterprising photographers, which have gained a more or less general approval of the public. At first, heads of a size from $\frac{3}{4}$ to 1 inch, and where more or less of the bust was visible, were all that was ventured. Soon the size of the head was increased to $1\frac{1}{2}$ and 2 inches, apparently at first in England, for the first cards of this kind which came into my possession were portraits of Boz (Dickens).

Although many objections might be urged against the adoption of

this size, still it has become more and more popular. I cannot help stating though that it is less suitable for the general public than for the heads of the ladies of the stage, with their rococo style of hair-fixings.

No doubt the unusual size of the head will show a richness of detail, as buckles, chains, chignons, curls, etc. But on the other hand, the danger is obvious that some undesirable details, as wrinkles, freckles, etc., become unpleasantly prominent in the picture.

The ladies of the stage have other means at their command to cover such shortcomings. They are in reality the inventors of a third kind of retouch, which, to distinguish it from positive or negative retouch, we have called the *original* retouch, as it is with paint, poudre de riz, and rouge, applied on the person itself, and at present this kind of retouch is in many of the Berlin ateliers (not only by ladies of the stage) practiced with good success.

With these large heads a careful study of illumination is of great importance. To this we must add negative retouching, which for obvious reasons becomes oftener necessary than in pictures of smaller dimensions, not to speak of removing spots.

Still another important element is the lens with which the picture is to be taken. On this point we have already given some directions. For thick faces use short-focussed lenses, and incline the camera slightly, so that the head will not be exactly in the centre. Slim faces are taken better in the middle of the ground-glass, with a long-focussed lens.

For the general photographer bust pictures without a background (vignetted) are doubtless the most convenient. Legs are excluded, and generally the hands also. He has no difficulty with the position of these extremities. He should pay the most careful attention to the head and chest, the upper parts of the arms, a pyramidal arrangement, and outlines. The figure itself is generally seated, being more steady than the slightly vibrating standing figure. The background should offer sufficient contrast that the outlines may not run together, but stand out boldly. For black hair there should be a somewhat lighter background, and for light hair a somewhat darker one:*

---

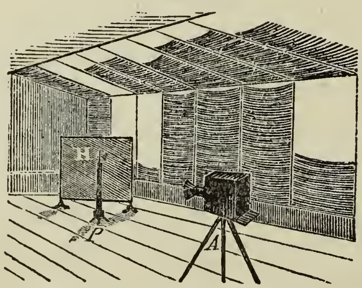
* It is certainly remarkable that the glaring white background in vignetted pictures does not offend our feelings, while otherwise we are horrified at every high-light in pictures with a full background. We can only explain this by the circumstance that our æsthetic feeling does not consider the white background as belonging to the picture. It appears to us as a part of the white paper, but not as an organic part of the picture. It is quite different with full backgrounds with designs on them. They pretend to belong to the picture, and are judged as parts of the same.

Lately, instead of the white graduated backgrounds, gradated ones and even black ones have been introduced—*i. e.*, the so-called Rembrandt backgrounds.

Mr. Kurtz and Mr. Baker have made the start, and I have seen pictures made by them in which almost the whole face is kept in a half shadow, and where the eye, contrary to the generally adopted and recommended usage, turns towards the light instead of the darker side, and this style is now quite general in America. Mr. Milster and Mr. Petsch, in Berlin, have likewise adopted this mode of illumination, but they employ a light background, and in so far they differ from the "Rembrandts." The following sketch by Mr. Grasshoff will explain the mode of making them.

A is the apparatus, *P* the person, *H* the background. The management of the side and top curtains is plainly visible in the cut. The illumination must, as Mr. Grasshoff distinctly states, vary with the person; accordingly more or less curtains are opened or closed,

Fig. 149.



and the camera is moved more to the right or left, as shown in the ground plan (Fig. 149).

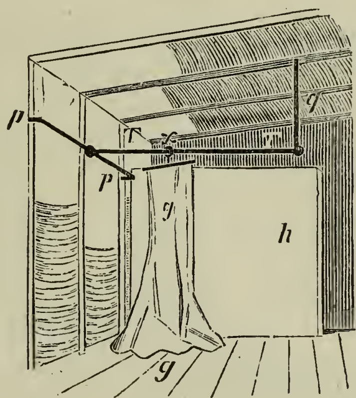
Special effort should be made to have the shadows well lit up. It might be said with much propriety that nature is not as black as shown in the "Rembrandt." This is very true; but we may say with the same propriety, that nature is not as white as represented in the toned pictures. However, the brown foundation as background to the picture has already in antique painting (Pompeii and Rome) done good service, which in modern times has been happily imitated.

Our modern painters too have monotonous, half-dark surfaces without any design, as backgrounds, only they treat them differently from most photographers. They appear unequally illuminated, dark on the one side from whence the light proceeds, and light on the side of

the shadows, and this is why the figure itself is plastically relieved from the background.

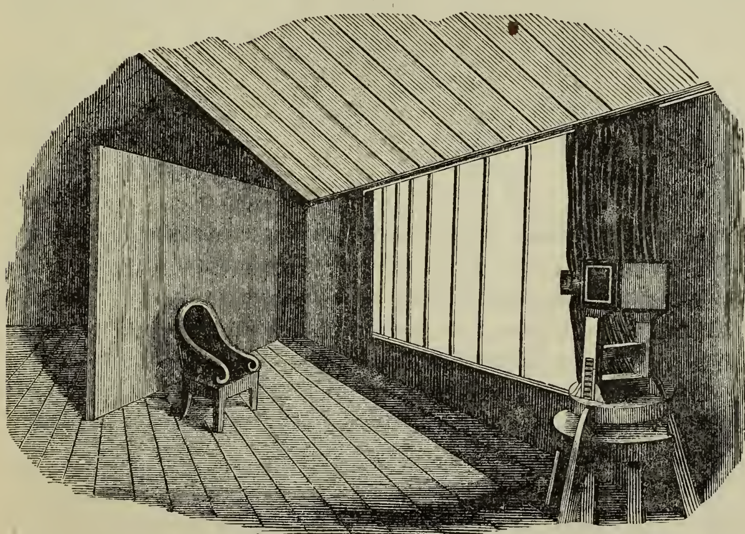
Such unequally toned backgrounds are obtained by shading them with some object, which is visible or not in the picture.

FIG. 150.



Loescher & Petsch use for this purpose a small narrow curtain *g* (Fig. 150), which can be pushed to and fro on the iron rod, *T T*. This

FIG. 151.



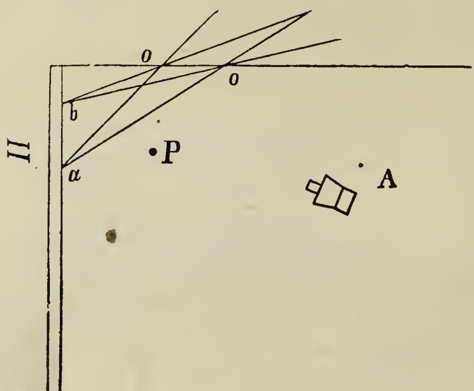
iron rod is hung at *q*, but can be moved on another, *p p*, so that it can be moved nearer or further from the background. The nearer the harder, the further the softer is the shadow.

Attention should be paid that the shadow be cast in such a manner that the illuminated side of the model is cast upon it, while the background behind the shadow side of the same remains light.

Adam Salomon, in order to obtain the same result, inclines his background, *i. e.*, he stands it obliquely, as in Fig. 151; the left side will be light, and the right dark.

Finally, we can effect the same result by raising, next to the person, *P*, a single curtain, *O O* (Fig. 152). The different parts of the background, *H*, appear unequally illuminated. *b*, for instance, although the glass side is nearer to it, appears darker than *a*, as is explained by the angles of light indicated in the figure. It is easy, by placing the apparatus *A* in a suitable position, to obtain the desired result. In order to light the shadows properly, a considerable quantity of front-light is necessary.

FIG. 152.

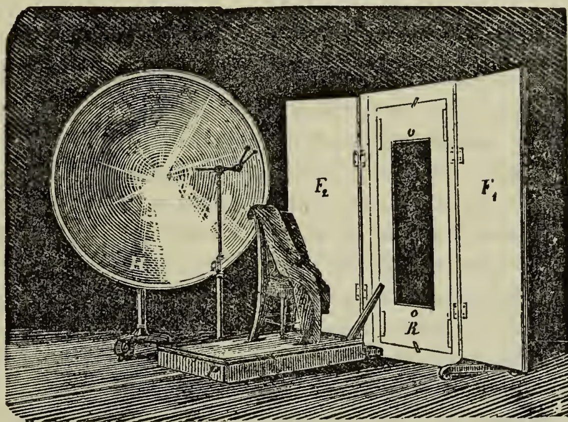


An excellent medium to produce a background, being light on the shadow and dark on the light side, is the funnel-shaped background of the celebrated photographer, Kurtz, in New York. This is round, of a funnel shape, about four feet broad (*H*, Fig. 153, and Fig. 155, *A* and *B*), being two and a half feet deeper in the middle than at the rim. This background properly set produces the desired gradations from light to dark.* A cylindrical background works similarly.

* The other pieces of Fig. 153, are a reflector with two wings, *F′ F′′*, and an opening, *o R*, through which the camera points, and which is very effective in "Rembrandts;" further, a movable platform, *P*, on which the sitter is placed. This platform will allow the placing of the sitter in any desirable position (profile, half or three-quarter face), without rising. Fig. 154 shows the position of the reflector, *R*, the person, *P*, and the background, *H*, in taking of "Rembrandts."

Lately a background has been introduced to the trade by Bigelow, which has the different gradations of light painted on it, which can be turned to place the light side wherever desired.

FIG. 153.



With bust pictures it will seldom be necessary to bring in other objects than the individual. It alone will fill the space, even if the

FIG. 154.

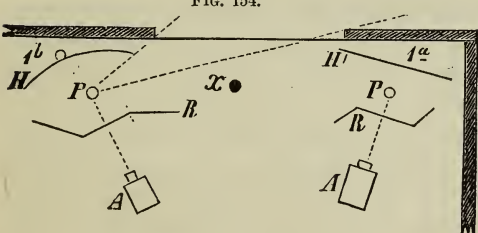
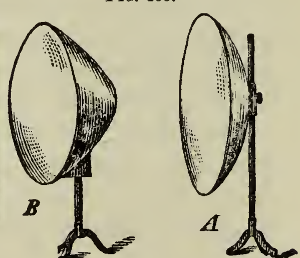


FIG. 155.



whole background should be printed in without any effort at vignetting.

It is different with three-quarter size or whole-length pictures, or when the body is in a sitting posture, or when it supports itself; then a pedestal or a stand is necessary, and we also require a floor. Even in such cases we do not hesitate to employ a monotonous background, and the care of the artist is confined to the chair, the floor, or the support (the table).

It is also necessary to observe that accessories must harmonize with

the main figure (see Arrangement, Contour, and Lines), and they must, because they are accessories, be secondary in importance to the main figure—*i. e.*, they must neither in shape nor in color become too prominent.

High-lights on furniture are horrible, but much more so are zigzag lines or ornaments which interfere with the harmony of the outline. A glaring design in the carpet or curtain is unbearable.

When these simple things offer already so much difficulty, how much more complicated must it be when the whole background is filled up with obtrusive painted landscape scenery or architectural objects. We can operate with real objects; we can place the figure in an arbor, in a window, or have a really papered wall, where everything which is necessary to the picture has been suitably selected and placed in the proper position. Or we have recourse to a painted background. There are many of them, which can be purchased from the stockdealer, but most of them are good for nothing.

One of the most striking shortcomings of the painted background is the accumulation of different objects and the diversity of the things so introduced; the number of the objects, which by their smallness are to indicate the distance, while the sharpness and solidity with which they are painted places them immediately back of the sitter, and the perspective becomes at once wrong when the camera is not placed at the eye-point of the picture.

It is perfectly clear that if natural objects are at all represented in the background, it should be done under the same conditions as the principal figure itself, and that the landscape should not have a different eye-point from the model.

The horizon, if it is represented at all, should be opposite to the lens. For a time it was the fashion amongst portrait painters to paint the horizon as low as possible. Of course the figure reached to the clouds, and appeared very gigantic; still, such a picture looks very untrue.

I will give, as an instance, the one picture of King Frederick William, in Berlin. He stands on the sandy plain, and in the distance is "Charlottenhof," *reaching as high as the knees of the figure.* Such a view could only be natural when the painter places his head on the ground, or when the figure stands on an eminence and the observer below. Reutlinger has made some good pictures where the figures reach to the clouds; so also has Robinson. The undefined cloud forms relieve the figure, and it is easy to place the light face against a dark cloud, or the dark hair against the light sky. But the horizon should not extend lower than the hips.

A faithfully drawn landscape, but without much detail, and which contains nothing which will draw attention to lineal perspective, in which, hence, *horizontal lines* are as much as possible avoided, will always be effective, and need not contain any gross errors, even if it is not absolutely true. Some backgrounds of Graf and Reutlinger show this in a remarkable manner.

Regarding the illumination of backgrounds, it may be difficult to get a perfect harmony between the illumination of the sitter and the objects forming the background. It is also necessary to change the illumination with the different models. Some require more top-light, others more side-light, while the illumination of the background remains unchanged.

This causes difficulties; but when the backgrounds are originally painted in a manner to correspond with the general illumination of the room, and when light and shade have not been placed in too violent a contrast, it becomes easy to avoid any striking errors. In landscape backgrounds top-light should predominate as corresponding with an open air effect, while for an indoor representation a side-light effect would correspond better with the light entering a room through the windows. It would of course be very bad taste if the sitter received the light from the right side, while on the background the light is painted as coming from the left.

I sometimes meet with queer combinations on the background. Papered rooms only separated by a balustrade from a rocky coast or a desert heath; ladies in a ball-room toilet amongst rocks and under a threatening, stormy sky,—follies which spring from thoughtlessness, and to which I need only give a passing condemnation. I must also condemn a combination of different styles of furniture, as Gothic, Renaissance, or rococo. Attention should be paid to style.

A *real* plastic decoration, as a pillar, a clock, a moulding, or a picture, will always be more effective, when the color has been properly selected, than a painted representation of the same object in which we always notice the pasteboard, not to speak of the incorrect perspective.

Loescher & Petsch have for this reason introduced real objects in the background in place of painted ones.

In the large cities it is easy to procure good backgrounds; but in the smaller towns the matter becomes more difficult. The photographer orders according to a sample. The sample looked very pretty and full of effect, but in using it everything turns out entirely different. What is to be done now? To alter it is difficult, hence it remains as it is, and awful things come to light. Still the fault is with

the photographer. The sample was taken under entirely different circumstances.

When some parts work too glaring, Mr. Grasshoff recommends the following background retouch: Some powdered yellowish-brown color, as, for instance, gold, or Roman ochre, or umber, should be placed in a piece of linen in the shape of a pad. With such a contrivance the light places are rubbed over, and the yellowish tone will produce a more subdued effect. In a similar manner spots that are too dark should be retouched with pulverized chalk. This will often be sufficient to harmonize effects, which are otherwise disturbing.

That the background appears lighter, if the person stands nearer, and darker, if he moves further away, we have already mentioned; that the background appears lighter if turned towards the open glass wall, is likewise a foregone conclusion. This can be seen with the naked eyes. In regard to the contrast between the lightness of the figure and the background, we have already mentioned the main principle. The object must always stand off perceptibly from the background. The background should, therefore, be darker for light hair, and *vice versa*. The color of the dress must also be considered.

The following rules should always be observed: Everything which is put in the picture, such as table-covers, curtains, and furniture, must be subordinate, and must not show more prominently than the person, and the lines and outlines of the portrait, the costume and everything, must form a harmonious whole with the above-named objects.

The less we stand in need of such accessories the better will it be. The painted background will never be more than a make-shift. It is a fault when the background occupies three-quarters of the picture, as we see it frequently. The size of the figure should bear a certain proportion to the whole picture.

It is astonishing how little space is necessary around the figure without the frame appearing too narrow. Take Raphael's Madonna Sedia, which contains three figures in the narrowest round frame, and still it does not make an unpleasant impression.

The effect of a figure with too large a blank space about it is easily seen in the medallion pictures, which are frequently taken with the carte de visite apparatus at long distances. On the large white paper the head appears much smaller than if we cut it out and look at it separately.

It is also well known that a standing figure appears more slender when the head touches the upper margin of the paper, and to the

right and left much open space is left; so also does the figure appear stouter when much upper space and no side margin is left.

Of how much importance accessories are, the following communication of Mr. Prümm will explain:

A little lady, only four feet high, complained to this gentleman that in all her pictures she looked so very diminutive. Mr. Prümm knew how to obviate this; he placed the lady next to a toy table in front of a plain background, and took a three-quarter length picture. Alongside the little table the lady appeared very large, and she was highly pleased with the effect. Such contrasts have in many instances extraordinary effect.

The same which we have said before in regard to disorder in the background refers with increased force to the foreground. It is wrong to place a carpet with a striking design or glaring colors in the foreground. Such designs are positively ugly when their figures do not correspond with those of the picture.

A carpet with dull colors and a "quiet" design is the best for full-length pictures. Very often the lustreless, simple floor, or a grass carpet—the latter of course with landscape background—is the best.

Finally, there should be harmony between floor and background in shape and color. A background which is placed an inch above the floor, and separated from the latter by a black line, will always make a "stagy" effect. It is also self-evident that a figure cannot throw its shadow upon a landscape which is considered to be miles away. A certain distance between the person and the background is necessary.

But now to the conclusion,—for the one anxious to learn and to improve, it may come too soon; for the impatient, too late.

I can only give outlines. The realm of art is as infinite as the realm of science, and many a one will exclaim: Too much, too much! how can we practical photographers pay attention to all these trifles? *Arrangement, Outlines, Drapery, Background, Accessories, Perspective, Position, Illumination, etc., etc.?* It is of course too much for the lazy one and for the thoughtless one, but not for the one who strives to excel.

In the world of art the greatest masters have gained the highest success by restless study and indefatigable labor. Look at the studies of Raphael; they are the mute and yet eloquent witnesses of the colossal preparations which this greatest painter of all times made before he attempted such creations as the "Disputa," "The School of Athens," "The Sibylla," and other masterpieces. And it is fortunate that photography is not only a mechanical trade, but a profession

in which the intelligent and ambitious artist will always outdistance the merely mechanical worker.

I hope, then, this book of mine may encourage the student to work on, and let him remember the words of Socrates:

"The beautiful is difficult."

SUPPLEMENT.

For the convenient calculation of the gramme weights, used repeatedly in this book, into ounces, we append the following:

WEIGHTS IN PHOTOGRAPHY.

Two systems of weights are in use:

1 ounce = 8 drachms = 24 scruples = 480 grains.
1 kilogramme = 2 pounds = 1000 grammes.
1 gramme = 10 decigrammes = 100 centigrammes = 1000 milligrammes.
1 drop (English minim) is about equal to 1 grain = 6 centigrammes.

English and American formulæ are generally given in ounces and grains. The following table facilitates the conversion of the one system into the other:

English Weight.	Decimal or French Weight.
Grain 1	= 6.25 centigrammes.
" 2	= 12.5 "
" 3	= 18.75 "

French Weight.	English Weight.	French Weight.	English Weight.
1 gramme	= 16 grains.	11 grammes	= 176 grains.
2 "	= 32 "	12 "	= 192 "
3 "	= 48 "	13 "	= 208 "
4 "	= 64 "	14 "	= 224 "
5 "	= 80 "	15 "	= 240 " = 4 drs.
6 "	= 96 "	16 "	= 256 "
7 "	= 112 "	17 "	= 272 "
8 "	= 128 "	18 "	= 288 "
9 "	= 144 "	19 "	= 304 "
10 "	= 160 "	20 "	= 320 "

1 cubic centimetre of water = 1 gramme = 16 grains.
32 cubic centimetres of water = about a fluid ounce.

INDEX.

ROBINSON'S

PHOTOGRAPH TRIMMER

IS A SUBSTITUTE FOR A KNIFE

For trimming photographs and does the work much more expeditiously and elegantly than a knife.

It Saves Time, Saves Prints, and Saves Money.

The accompanying cut represents the instrument in the act of trimming a photograph. It does not *cut*, but *pinches off* the waste paper, and leaves the print with a neatly bevelled edge which facilitates the adherence of the print to the mount. Try one, and you will discard the knife and punch at once. For ovals and rounded corners it is worth its weight in gold.

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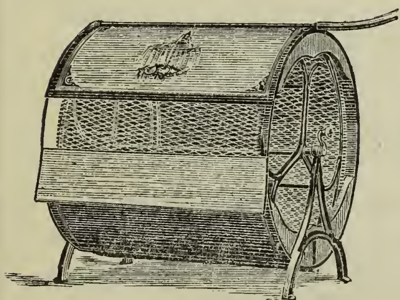

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New in Principle—Quick and Reliable in Practice.

Instead of soaking the Prints it applies the water in the form of spray, with considerable force, to both sides of the paper at each revolution, or from one hundred to one hundred and fifty times per minute. Washes with exact uniformity, and gives more brilliant and permanent work; is simple, not liable to get out of order, will last a lifetime, and will enable you to get out work at short notice, thereby securing many orders that would otherwise be lost.

Size Cylinder.		Capacity in Cards.	Largest Print.	Price.
Diam. 16 in.,	Length 14 1-2 in.	84	14 by 17 ins.	$30
" 20	" 19	144	18 by 22	40
" 25	" 24	220	22 by 28	50

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DEAR SIR: The Washer is splendid! Could not do without it. It washes the prints better in fifteen minutes than by the old tank process in all night. Wishing you every success, we remain,

Very truly, E. L. BRAND & Co.

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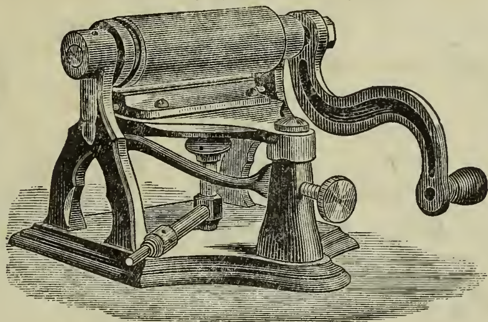
Patented May 20, and December 2, 1873.

THEIR VALIDITY ESTABLISHED BEYOND DOUBT.
THE OPINIONS OF EMINENT COUNSEL GIVEN IN THEIR FAVOR.



TWO THOUSAND Machines in use, sold in less than one year, speaks volumes for the Enameler as a triumphant success.

FIRST PREMIUM GOLD MEDAL. The Scovill Gold Medal was awarded by the National Photographic Association of the United States to WM. G. ENTREKIN, for his Oscillating Enameler for Burnishing Photographs, Chicago, July 16, 1874.

FIRST PREMIUM SILVER MEDAL. Awarded by the Franklin Institute, of Pennsylvania, Philadelphia, November 26, 1874, to WM. G. ENTREKIN, for his Oscillating Enameler.

I have guaranteed the validity of my patent to all who make, sell, or use it, and have covenanted to defend them against any and all suits for infringement by the following guarantee:

WHEREAS, ——— has purchased Photograph Burnisher No. —, of my invention, and made under my Patent No. 145,161, granted December 2d, 1873, I, WILLIAM G. ENTREKIN, hereby covenant and agree to warrant and defend the said ———, his heirs, executors, administrators, and assigns, in the use of said Burnisher, against the consequences of any and all suits for infringement which may be brought against him by the owner or owners of any other Photograph Burnisher whatsoever.

IN WITNESS WHEREOF, I, the said WILLIAM G. ENTREKIN, have hereunto set my hand and seal this —— day of ——, A.D. one thousand eight hundred and ——. *WITNESS:*

I deny that my patent infringes the patent of Weston & McDonald in any particular, and in support of that denial cite the following opinion of eminent counsel:

WILLIAM G. ENTREKIN. WASHINGTON, D. C., Friday, June 5, 1874.

DEAR SIR: Yours is just received. You need not fear any trouble from any parties in regard to the Weston Machine, Your Burnisher does not infringe with any feature of the Weston Machine in the least particular. You can therefore manufacture and sell your machine with impunity. Yours truly, C. M. PARKS,
Attorney-at-Law and Solicitor of Patents, Late Examiner in Patent Office.

STANSBURY & MUNN,
Attorneys and Counsellors-at-Law, and Solicitors of American and Foreign Patents,

W. G. ENTREKIN, ESQ. WASHINGTON, D. C., August 7, 1874.

SIR: I have examined reissued Letters Patent No. 5281, granted February 11, 1873, to Weston & McDonald, and your Patent No. 145,161, of December 2, 1873, for Photograph Burnishers, and am of opinion that your Burnisher does not infringe the Weston & McDonald Patent. CHAS. T. STANSBURY.

WILLIAM G. ENTREKIN, ESQ. PHILADELPHIA, September 3, 1874.

Having examined Letters Patent No. 145,161, dated December 2, 1873, to William G. Entrekin, for an improvement in burnishers for photographs, and also reissued Letters Patent No. 5281, dated February 11, 1873, to E. R. Weston and T. McDonald, for a similar invention, I am of opinion that burnishers constructed according to the Entrekin patent do not infringe the patent to Weston & McDonald.
Yours truly, GEO. HARDING, *Attorney-at-Law.*

PRICE LIST.				
	Cabinet Size, 6 inch roll...	$25 00	10 x 12, 14 inch roll.........	$50 00
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W. G. ENTREKIN, *Patentee and Sole Manufacturer,* 4382 & 4384 Main St., **Manayunk, Phila., Pa.**

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